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WEST EUROPE..............ivory
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SCIENCE & TECHNOLOGY

CHINA

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DESCRIPTION OF NETWORKED UNIX SYSTEMS

Shenyang XIAOXING WEIXING JISUANJI XITONG [MINI-MICRO SYSTEMS] in Chinese
No 1, 8 Jan 86 pp 15-22

[Article by Liu Fangming [0491 2397 7686]:   "The Networking Function of UNIX
and Networked UNIX Systems"]

[Text] I. Preface

At present in this country, dissemination and applications of UNIX systems are
developing rapidly, which has led to a day-by-day increase in users of UNIX
systems.   For these reasons, how to connect UNIX systems into networked
systems has become a rather pressing matter, so I here intend to describe the
UNIX networking function and networked UNIX systems to interested readers.

II. The Networking Function of UNIX

2.1 Networking Requirements

The traditional method is to set up specialized structures to be responsible
for distributing the operating systems and relevant programs from the central
station to each different user.   Consequently, as far as UNIX systems are
concerned, on the one hand, software distribution and maintenance problems are
greatly increased, and on the other hand, each UNIX station can alter and
expand UNIX, even to the extent of developing general-purpose utility
programs.   Therefore, each station is also a redistribution central station
for software maintenance and for certain special utilities.

In addition to all this, a single computer cannot satisfy the needs of a large
project, and sometimes it is possible that a group of UNIX users will be
simultaneously using certain machines, such that it would be hard to avoid
passing news, data, and other information among several machines.

Under current conditions where in this country there is a constant increase in
the number of UNIX users, it is ever more apparent that the two problems just
discussed are becoming inevitable.

2.2 Design Goals

First of all, the design goal pursued in dial-up UNIX networked systems is to connect together as many UNIX stations as possible at the least possible cost, and this is also why this system connects UNIX stations together primarily with dial-up lines. Dial-up lines are low speed, and are commonly busy, so the times for transmitting files will be rather long. Therefore, dial-up network systems should relegate transmission tasks to be handled as background tasking. The average UNIX user is not willing to buy special hardware and make system revisions for the sake of networking, so in consideration of this point, the dial-up systems will drop the work required to enter a local station to the lowest priority. Its implementation does not require alteration of the operating system. Actually, the transfer procedure from one machine in the network to another will be the same as if a terminal user were to enter the system via dial-up ports.

There are two categories distinguishing stations in the dial-up network system: active systems and passive systems. Active systems are those systems having automatic call components or that are connected to other systems via hardwire connections, and can therefore initiate a connection, while passive systems have no hardware for initiating connections. Consequently, active systems can call passive systems, as well as do work there. This allows the passive systems and active systems to be indistinguishable in using the network function, the only difference being that the active system be the initiator. People regularly enter an active system and request to copy data from one passive system to another passive system, and although this requires two telephone calls, it is still faster than sending magnetic tapes by post.

Dial-up systems certainly do not put an end to using communications lines. By using hardwired communications lines you can certainly improve the rates of transmission, and can connect together several channels of communications. The transmission rates for dial-up connections is generally from 300 to 1200 baud, while those for hardwired connections can be 9600 baud or higher. Therefore, this system uses the principle of progressive escalation according to need: a station first generally enters the network as a passive system, then when it is discovered that it is necessary to add an automatic-calling component, it becomes an active system. Finally, a high-speed connection can be established with a system with which it must undertake large-quantity transfers. There is no doubt but that when a user is changing his mode of connection with the network he must change relevant routines and some help files.

The basic operation of this network is extremely simple: each system added to the network has a spool directory, in which are the tasks (files to be moved, or commands to be remotely executed) to be accomplished by using the network order functions. The standard program uucico handles all transmission tasks: it first recognizes the special communications channel for the station asking to have conversation with it, then selects a device and establishes the connection. It then goes on to log in the remote machine and initialize the uucico in question. As soon as two uucico's are connected, they must first negotiate the line protocol, then begin exchanging tasks: beginning from the calling program, each program successively transmits the things that are necessary, after which it requests the other party to complete the tasks that

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it has requested. This proceeds until the business of both parties is completed, after which each exits.

By using this method, each station can attain the services of all other stations. Naturally, passive stations must wait until called. Various different protocols may be selected in accordance with actual conditions, which is to say that as long as the caller and the called programs have a common protocol, communications between them may be achieved. Not only that, but each caller knows the time at which each target system should be called. If the target system temporarily cannot be called, the data being transmitted for it is stored in the spool directory until the target machine can be reached.

Each station has its own specialized programs and data, and if network systems are to be implemented at these stations, there must obviously be a certain involvement with file-access management and file safety and protection. At the same time, each station must limit and supervise transmission tasks, and if a user wants to access a file, he must come within the jurisdiction of the machines involved with this file and of the accessed file itself. To achieve this goal, the user must first use his password to log into his local computer. Then, by means of his local computer, he must again log into the machine having the file he is to access. Also, each station keeps a record indicating all files moved into and out of that station, as well as indications of corresponding file-access requests. Some stations only allow users to make requests for the completion of their tasks. Then, before the station actually does what the user has requested, it will make a return call requesting the user. In this way, be it the target computer or the original system, all can guarantee that the request is correct. Also, because there has been a return call, just because a user knows the necessary password, he cannot pretend he is another user.

Each machine can selectively maintain a sequential tally for conversation with other machines, and then this tally can be confirmed as each conversation begins. In this way, even though the call-back technique is not used, to pretend successfully to be another person, the caller must also provide the correct sequential number. Even though the pretender satisfies other fraudulent conditions, it is not possible that he can obtain this sequential tally. Therefore, even though the pretender is successful on one occasion, he will be discovered at the next conversation.

2.3 Matters Relevant to Communications Processing

Two communications commands are provided for users of this system: uucp takes care of file copying, and uux implements execution of commands requested by its resources that the local computer cannot completely satisfy. These two commands place all tasks to be done and data files into the spool directory for execution by the uucp manager (dem on s).

The uucico program implements all communications tasks between the two systems, and accomplishes the following functions:

--scans the spool directory for tasks
--sets up calls for the remote system
--negotiates the line protocols to be used
--initiates the uucico on the remote computer
--executes all requests from the two systems
--records task requests and task-completion conditions

To summarize, there are three paths by which to initiate the uucico: 1) initiated by the system manager; 2) initiated by either uucp or uux; 3) initiated by a remote system.

What follows is a more detailed explanation of matters related to each step of the tasks just described:

2.3.1 Search Tasks

If a file name is to be entered into the spool directory, uucico and uuxqt can determine the files that ought to be searched, the remote computer to be called, and any special file-handling sequences for the remote computer.

2.3.2 The Calling Remote System

For calling, file information should be used that is stored in the uucp program directory and as the calling begins, the system being called should be locked to screen off calls from other callers.

The name of each branch station system may be found in the "system" file, and each system includes the following information:

1. system name;

2. the time to call this system (day of the week and hours within a day);

3. the devices and device types used in calling this system;

4. the speed of the communications lines of this system;

5. the telephone number of this system;

6. registration information for this system.

As to whether or not it should be called, the current time should be compared with the time field, the telephone number can include abbreviations (as for example "nyc" and "boston"), and "dialing code files" can be used to convert these to the dialing number sequence. In this way, even if there is a local change in the number of the telephone service, this allows each station to store the same telephone number.

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Since uucico uses fields (3) and (4) in the "system" file to scan the
"devices" file, it can find the connection devices to be used. The uucico
will test each device that satisfies (3) and (4) until the connection has been
established or until there are no more devices to be tested. If a
nonmultichannel device has been opened, then a locked file will be set up to
prevent another uucico from using it. When the connection has been completed,
the information provided by login is used to log into the remote system, after
which a command is sent to that remote system to initiate the uucico program
on it. The conversation between the uucico's on the two systems begins with
their "handshaking," by which handshaking is meant the activity initiated for
the SLAVE system: the SLAVE sends out a piece of information to allow the
MASTER to know it is ready to accept the system identifier and the
conversation-sequence series, after which the MASTER makes a response, and
when the SLAVE acknowledges this response, protocol selection begins.

2.3.3 Selection of Line Protocol

The remote system issues the information:

    P proto-list

Here, the proto-list is a string of characters, where each character
represents a line protocol. The calling program checks the proto-list,
searching for a letter corresponding to a usable protocol, then returns
information regarding use-protocol, where the use-protocol is:

    Ucode

Here, code is a character protocol letter or the letter N signifying there is
no common protocol.

2.3.4 Handling of Communications Routines

In the communications process, one uucico is the MASTER and the other the
SLAVE. In the beginning, the calling uucico is the MASTER, while the called
uucico is the SLAVE, and during the conversation these roles could change
several times.

There are four categories of control messages, where the first character of
the message is used to distinguish the type. They are:

    S send a file
    R receive a file
    C copy complete
    H hang up

The MASTER will send the R or S message until the tasks in the spool directory
are completely through, upon which completion it will send an H message. For
each request, the SLAVE will provide an appropriate response corresponding to
"yes" or "no": SY, SN, RY, RN, HY, HN.

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The send and receive replies depend upon the access authority to the requested file or directory. After each file has been copied into the spool directory of the receiving system, the receiver of the file will send a copy completed message. If the CP command in the copied file of the spool directory is successful, a CY message should be sent, or otherwise a CN. Task requests and results are all recorded in both systems, and if the user so requests, a mail message will be sent to the user reporting completion of the request (the user may also request at any time to see the status information in the log routine).

The response to a hang up is determined after the SLAVE program has scanned the spool directory. If there is a task in the spool directory that involves the remote system, it will issue the HN message, and the two uucico's will exchange roles. If there is no task, an HY is sent.

2.3.5 Conversation Concludes

When the MASTER receives an HY message, it will return that to the SLAVE, and the protocol will be interrupted. Each uucico then transmits an "oo" message to the other party.

2.4 Current Conditions of Usage

The most direct application for communications software on this system is for telecommunications mail. By typing "mail dan" at one station of the network, a letter can be sent to "dan," and by typing "mail usg,dan" the message can be sent to Dan of the usg group.

At present, the basic use for this network is software support; new programs or new editions of programs can be transmitted to users, or some potential errors can be reported to the authors. For the purpose of uniform handling, a "stockroom" can be set up, which allows the remote user to call and request software. The "stockroom" is actually a "stock table" of usable programs, to which new error corrections and utilities are periodically added. By this method, a user can obtain the newest version of any program without disturbing the author. Although the "stock table" is maintained on a particular machine, the objects in the "stockroom" are distributed all over, and in normal conditions a program will be placed at the station of its author, to be sent out from there. Remote copying is done by uucp, so there is no problem implementing the considerations just described.

Another use for software maintenance on this network is to compare the files on two different machines. There is an extremely useful utility in uuix called "diff," which progressively compares two texts, indicating where they are different. Similarly, uudiff in this network will compare two files or directories on two different machines.

When there are many files, there are often equivalents. To avoid moving files of this sort, uudiff calculates a checksum of the files on both sides and only transmits those files that are different after that careful comparison. As for large files, this process may be repeated, and a checksum may be calculated for each line, where only differing lines are transmitted.

The uux command is very useful for remote output, as for example when the following condition is encountered: some machines do not have hardcopy devices, but if they can connect to machines with printers through 9600 baud communications lines, then the uux command will allow the printer to output on the local computer formatted, and by using standard UNIX commands this will be printed at the remote computer.

III. Networked UNIX Systems

3.1 Preface

Standard UNIX organizational structures have simplified the design of networked UNIX in several aspects. Therefore, UNIX network interface programs are richly endowed with features: 1) The system can work under various network hardware interfaces, and is not limited only to operation on the ARPA net. 2) Interface programs occupy only about 3.5K of 16-bit words in internal storage. 3) A protocol status machine is implemented from a natural machine, for which reason protection is extremely easy. 4) The interface between the user and the network interface is extremely easy. 5) The network interface programs are, like the UNIX system itself, written in a high-level language. 6) Networked UNIX systems can quite easily act as connected machines to the ARPA net and other networks.

Networked UNIX systems are currently being used to establish complex network structures. What is especially worth pointing out is that after trimming, this network system can be easily used as a satellite processor for large systems. Similarly, several of these UNIX systems can be interconnected for multiple-channel processing and resource sharing.

3.2 The Structure of the Network Interface Program (NIP)

The network interface program of networked UNIX systems is composed of three parts: the network control program (NCP), the protocol program, and the network special files. In that, the NCP is composed of two portions: the NCP core, which acts as the UNIX code resident in memory; and the NCP manager (dacman), which is the background terminal cycle process in the system at the user level. The NCP manager does host to host and ICP protocol (Footnote 1) (ICP: Initial Connection Protocol, the standard structure for establishing connections among processes between two stations on the ARPANET). The NCP core is IMP (Footnote 2) (IMP: an interface message processor on the ARPANET, which is the host machine for ARPANET), serving the NCP manager and the user programs. The protocol procedures are executed in the user space, and they use the NCP core and manager to effect a higher level protocol. Network special files provide a basis for contact between the user programs and the NCP. The NCP core (occupying 3.5K words) is the only resident software component in the NIP. The NCP manager (about 8K words) and some other routines are only loaded into memory when needed. The NCP is primarily needed for opening and closing the network connection, while the NCP core is responsible for managing the network data flows. This method that separates to control greatly reduces internal storage while not sacrificing performance.

Actually, the NIP can operate within 32K bytes of memory, which is the smallest amount of memory needed by standard UNIX.

3.3 Network Special Files

In UNIX, special files use a character string that is the name of the physical device to represent the integer name that is substituted in UNIX internally. Network special files do about the same thing, as they substitute the network station name as the station name. In the directory /dev/net, the network special files will use "/dev/net/harv," for example, to represent the Harvard PDP-10 and "/dev/net/london" to represent the front-end processor PDP-9 in England. There is a rule that the network special file host device number is 255, which is to distinguish it from the host device number of other standard UNIX devices. Also, the secondary device number of the network special file is a network signifier given by each corresponding host.

3.4 The Interface Between UNIX and the NCP

By using standard UNIX I/O calls for the network special device files, it is possible to access network software. This means that as long as languages provide a standard interface to the files system, programs written in all kinds of languages can be used to access network resources, and this is the most natural usage interface a user could hope for. In this way, the open command establishes a connection between the service processes of the calling program and external station machines. The read and write commands will transfer data between the processes of the connected systems, while close will terminate this. The form of the connection open call is as follows:

    fd = open("dev/net/hostname," mode);

If the open command returns a descriptor word greater than 0, this says that the connection has been successful, and otherwise it returns a negative 1 to indicate failure. The first parameter in the command is the path name for the network special file requested. The second parameter has a value of 0, 1, or 2, which indicate that the requested connection is read-only, write-only, or read/write, respectively (i.e., standard Telnet). As it happens, this interpretation coincides with the setting of mode values in standard UNIX to be 0, 1, or 2. However, if when using the network open command, any other value is set for the mode, this value will be interpreted as the address of the control block in the user program. The contents of the control block and their significance are as follows:

type: refers to:

               (1) the local socket (Footnote 3) (The socket is an input/output
               aperture, and the socket number is a 32-bit conversion value,
               signifying a software I/O aperture in a particular process. In
               ARPANET, a process is identified exclusively by the station
               number and the socket number), whether or not there is a request
               for a connection to an external machine;
               (2) whether it is a simple or full duplex connection;
               (3) absolute socket number or relative number for the relative

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base address;
(4) whether expects ICP or a direct link.

fileid: when this is open refers to a file descriptor used for an
               already opened network file;

local
socket: refers to a local socket number;

foreign
socket: determines an external socket number;

host: determines an external station machine;

byte: determines the size of the connection byte;

alloc: determines the smallest value for an allocation command to an
               external station machine;

time: the time to wait for an external host to accomplish the
               requested task.

If all fields in the control block are at zero, then the NCP will use the
omitted value at its corresponding position. The method provided by this
control block tactic to open a network connection is quite flexible, and
greatly simplifies the task of implementing high-level protocols.

The read/write/close call is the same value as for standard UNIX, and they
have the following forms:

nbytes = read (fd, buffer, count);

nbytes = write (fd, buffer, count);

status = close (fd).

The parameters for these calls and the contents of the resulting values are
identical with those of corresponding calls in standard UNIX.

We   should point out here that although ARPANET has actually defined
"interrupt" signals on the link, at present the UNIX NCP does not yet have
this kind of structure. Actually, the commands for the file system noted here
do not provide for a natural interrupt structure, and consequently, standard
UNIX still has signal calls, which the user program uses to determine the
address of a software process, and this process is used by the system to take
care of peripheral events.   Normally, this kind of event is illegal.   Of
course, this structure can be forcibly used to handle the goals of incoming
interrupt signals, and sending out an interrupt signal could be generated by
various different software structures, but at present it is not felt that
there is any necessity to implement these interrupt facilities.

(1)   (2)   (3)   (4)   (5)   (6)   (7)   (8)   (9)   (10)   (11)   (12)   (13)   (14)
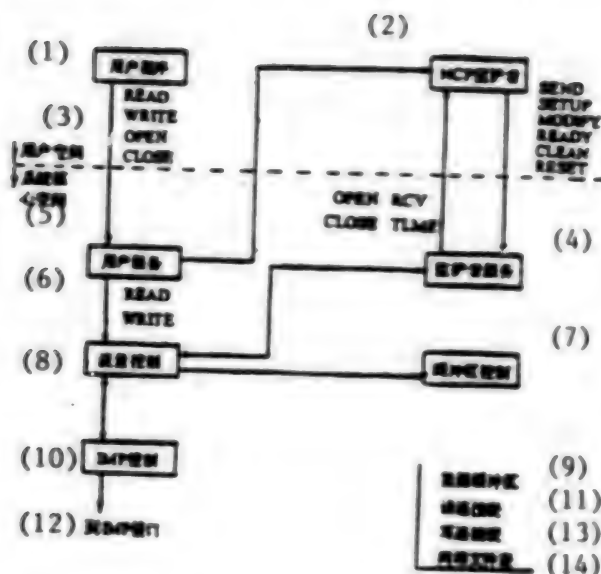
Key: 1. user routines
      2. NCP manager
      3. user space
      4. manager service
      5. system kernel space
      6. user service
      7. buffer control
      8. flow control
      9. data buffer
      10. IMP control
      11. read connection table
      12. to IMP interface
      13. write connection table
      14. network file table

3.5 The NCP Core

In the figure above, the NCP core is the portion shown below the dotted line.
The primary data structures associated with the NCP core are the read and
write connection tables, the network file table, and the data buffer. These
structures will use structures already existing in the UNIX core, especially
the inode, the file block, and the core buffer.   The NCP core makes use of
existing UNIX processes to manage these structures.

3.5.1 User Services

The system call structure in UNIX effects communication between a user program
and a user service routine. Four expanded statements are added to the
standard UNIX base that can discover and handle calls by the user to network
files, and this is the only modification of standard UNIX for implementation
of the NCP.   All the work they do is to check calls to the special file for
host device #225. The system calls distinguished by this simple structure are
transferred to the NCP core, and the open/close requests among these are then

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sent to the NCP manager from there, while transmission requests are handled by
the core.   Communication between the NCP core and the NCP manager is realized
through a special file (/dev/ncpkernel).   Unlike the network special file
described in 3.3 above, the ncpkernel file has the ordinary UNIX primary
device designator, but the device driver routines for /dev/ncpkernel are
actually the NCP core.   More particularly, by allowing UNIX to have this sort
of functional component, it allows read/write calls to the /dev/ncpkernel to
be handled by routines in the NCP core.   These routines are transmitted data
between the manager buffer in the user space and the core buffer in the core
space.

3.5.2 Connection Tables and File Tables

It is just like for ordinary files in UNIX: after network special files are
opened, they will use some similar data structures, but in this case because
calls to the network special file are shifted to the NCP core, the NCP can use
the major portion of the space in the data structures for its own purposes.
The network special files use the inode to indicate sockets, while the control
block for each standard file can point to 3 of these sockets.   The inodes of
these sockets contain information: a bit counter, station and link data, and
other parameters for network flow control.

As far as each local socket is concerned, its register is kept in the
read/write connection tables (the read table register reads the socket, the
write table register writes the socket), and items in the read/write
connection table include a pointer to a register socket, as well as external
station numbers and link numbers.

The network file table includes a pointer, pointing to the system file-control
block established for a network file already opened (i.e., the connection
table).   This file table is the basis for implementing communication between
the NCP core and the NCP manager.   The network files that have been opened are
searched for through their subscript indexes in this file table. The sizes of
the files tables and the connection tables are constants at the time of
compilation, and 32 items have been established in the current system.

3.5.3 Buffer Control

The buffer control portion of the NCP core manages a 64-byte buffer pool in
the buffer area, which is derived from the 512-byte buffer in standard UNIX.
The NCP takes eight 512-byte buffers away from UNIX, and when not using them,
returns them.   Some other processes are placed in the buffer-control portion,
and these are used to connect messages together, to append data after
messages, and to copy data back and forth in the user space, etc.   The
messages to which we refer here are the regulatory messages between the IMP
and the host station, that is, network transmitted data, which can occupy
several small 64-byte buffers.

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3.5.4 IMP Control

The IMP control portion handles protocol between IMP and the host station, as
well as some other events of data transmission between the host station and
the IMP.

3.5.5 Manager Service Routines

The manager service routines handle commands coming from the NCP manager (like
SEND), and issue messages to the manager (rcv).   SEND is used by the manager
to send protocol messages to other host stations.   Some other commands are
recognized by service processes of the manager, and they are used to modify
the kernel data structures in accordance with indications from the manager
(the connection tables and file tables).

3.5.6 Control of Flow Quantities

The key to implementation of this resolution-type NCP is the flow-quantity
control component, which component kernel does user data flow control in
accordance with the protocol from host station to host station. This requires
1) sending set commands to external host stations; 2) receiving rules from
external host stations; 3) maintaining the message and byte counter that are
affected by the set commands and data structures; 4) accomplishing the
reformatting of protocols. User read/write and flow control handling routines
are always resident in memory, and for this reason the rate of transmission of
data back and forth between nodes is quite effective.

The implementation of flow-quantity control in networked UNIX is affected by
the limits of memory storage in the system, and this is because the system
must operate in the 32K memory of the PDP machines.   The algorithms are as
follows:

a.   A process writes things to an external host, which are accepted in the
buffer of the NCP core, the buffer being limited to 4,096 bytes.   When the
writer has reached this limit, it then sleeps and waits until some of the
buffer contents have been sent to the external processor.

b.   The head of each message that enters UNIX from an IMP will be tested in a
special fixed-buffer pool.   If the head of this message indicates that it is
just a portion of a regulatory message, then as needed it will be allocated to
buffer space outside of the buffer pool.   If there is temporarily no usable
space, the kernel process for reading data in that IMP is locked until the
process releases space and the original statement is awakened.

If an algorithm is necessary that is faster than this, more memory capacity is
needed, and large processors with empty memory can allocate large virtual
buffers for each station connection that is opened.   Actually, the size of
virtual buffers are in relation to the capacity of the processor.   Using the
PDP again as as an example, the memory-management component of the PDP-11/45
can to a certain degree implement large virtual buffers, while the PDP-11/40
cannot.   At present, the distribution range of machines for systems running
UNIX is quite broad, and for this reason compatible algorithms should be used.

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3.6 The NCP Manager

In UNIX, the manager is the cyclic process that runs the user programs. Its inputs include open and close from the NCP core, or the rcv command. These commands are read from the communication file /dev/ncpkernel. It is just as described in 3.4 and 3.5 above, open and close are generated by implementing open ( ) and close ( ) calls in the network special file, the calls are issued by the local user, while the rcv command indicates matters concerned with receiving network communications to the NCP manager.

A large part of the time for the NCP manager is sleeping and waiting for the completion of read requests for the /dev/ncpkernel communications file. But when input commands arrive, the NCP manager will react in different ways: 1) it will modify its internal data structures. 2) It will send out protocol messages to its host computer.   3) It will issue commands to the NCP core. 4) It will record the statistical data and events of external files. In accordance with the socket status and the status of files concerned with commands that come in, the NCP core can access the arbitrarily composed formats of actions described above. This includes not doing anything, which from this point of view can allow the NCP manager to be seen as a limited-status machine. For each input, it will calculate the next status on the basis of the current status and output that. Actually, the function to change the status of the manager program is determined by a single socket and the network file. When the input command of the manager is decoded, it will determine the network file or socket that will be affected. Therefore, the status machine in the NCP manager will consider only one network event at a time.

The most complex status machine in the NCP manager is the "socket machine." Each socket has nine possible states (two obey states, two vfc states (Footnote 4) (vfc: request host for connection)), four states concerned with closure, one release state, and one NULL state) and the socketed machine can accept the following nine input command operations:

--two await commands;
--local vfc command;
--externally derived vfc command;
--externally derived close command;
--local close command;
--NCP manager close command;
--time exceeded command;
--external host break down signal.

In this way, it is possible to generate 81 states, but because there are only 25 exclusive actions to be done in the 81 possible states, in actual real-time situations, this is not all that complex. Each possible action is treated as a function to be implemented, while the status table is just a 9 X 9 function address matrix. The status table indicates the function that should be called for a given condition, while the next state is determined by the numerals in each function.

3.7 The Current Situation Regarding Use of Networked UNIX

At present, networked UNIX supports Telnet (Footnote 5) (A protocol where the local user logs into an external host) and FTP (Footnote 6) (File transmission protocol) protocols: the user can use Telnet to log into an external host, or for transmitting files between the UNIX system and external host stations having the FTP service routines. Naturally, Telnet and FTP service routines were designed with UNIX in mind, the goal of which is to simplify the software resources on the network that UNIX users share and modify on ARPANET.

Because UNIX largely uses the standard UNIX file system functions for the NIP interface, so it is very easy to write network routines, at the same time the important portion of the UNIX shell commands is also significant among UNIX network routines. In addition to this, by revising the shell routines, this allows pathnames such as "/hostname/pathname" in designated external host stations to be interpreted as pathname. The following is a general example:

```
/host1/prog1/host2/path2 | /host3/prog2 | prog3 | Lpr&
```

This group command requires the simultaneous execution of prog1, prog2, prog3, and lpr, the & signifier indicating that these four routine systems are to be run as discrete background processes. In the command, the standard output of each routine to the left of the vertical bar is the standard input for the routine to the right of the vertical bar. In this way, the results of the execution of these routines are: prog1 runs on host1, and receives files from host2. The standard output of prog1 then acts as the input for prog2 running on host3. prog3 runs on the local system, then sends its output to the local line printer process.

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12586
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COMPRESSION STORAGE METHOD FOR CHINESE CHARACTER LIBRARY OF GRAPHIC PLOTTER

[Article by Liu Xiaoji [0491 2556 1015], East China Institute of Photo-
electric Integrated Devices; first paragraph is source-supplied abstract]

[Text] Abstract: The Chinese character library graphic plotter is the basis
for Chinese character output by computer graphic system. The Chinese charac-
ter graphic plotter proposed in Reference [1] has been applied very well, with
one drawback of excessively large storage requirements. This article sets
forth a paging storage method which will tremendously compress the originally
needed storage space.

1. Introduction

The Chinese character output capability in a computer graphic system is very
vital in the production of engineering graphics. Due to the functional
characteristics of graphic plotters, the Chinese character word form informa-
tion designed for Chinese character output on graphic plotters must be repre-
sented in line vector format in stroke style. A Chinese character library
specifically for use in graphic plotters based on the vector format with such
fundamental characteristic has been successfully developed [1]. This Chinese
character library contains in its entirety, all 6,763 Chinese characters as
spceified in the Chinese character symbol collection used in GB-2312 informa-
tion exchange. This library has enjoyed excellent application in various
fields.

However, the Chinese character library for graphic plotters as proposed in
[1] and [2] occupies a storage area of over 400 KB. This would present some
inconvenience in practical use as this kind of storage area is a little bit
too much for 8-bit or 16-bit microcomputer systems. For instance, the two-
sided, dual density 5¼" floppy disk for the presently popular IBM-PC micro-
computer can have 360 KB after formatting under the operating system. In this
case, there will be considerable inconvenience if the Chinese character library
for graphic plotters is used in an IBM-PC. This constraint is especially
apparent for microcomputers having only one floppy disk drive. Therefore, in
order to achieve a more practical Chinese character library for graphic
plotters, its storage area has to be compressed.

We elect a paging storage method to restore the Chinese character library for graphic plotters referenced in [1]. The storage area occupied by the Chinese character library for graphics plotters compressed with this paging storage method is reduced from the original 420 KB to 310 KB, a reduction of 110 KB, without reducing the library search speed. The compression rate is quite high, and the effect is prominent. After practical operations, in the areas of search speed, character quality, and search accuracy, the Chinese character library undergone paging storage compression has not been proven to be inferior to the original library, a quite satisfying result.

2. The Data Profile of Vector Chinese Characters for Graphics Plotters and the Storage Structure Characteristics

There is a relationship between the Chinese character word form representation used in a computer system and the external facility used by the system. The basic graphics images processed by the graphic plotter in computer graphic systems have always been vector straight lines. Therefore, in order to enable the plotter to plot a picture, we have to provide all the vector information about the picture. For example, for a straight line defined on the plotting plane, there shall be the following command format on DXY-880 Graphic Plotter

$$d\, x_0,\ y_0,\ x_1,\ y_1$$

The desired straight line is resulted for values d100, 100, 200, 200. Thus, in order to output Chinese characters on a graphic plotter, one must determine, on the plotting plane, the vector representations for various strokes in a Chinese character. Chinese characters can be obtained on the plotting plane of a graphics plotter when the vector information about the Chinese characters is fed to the graphics plotter and after a series of transfers.

There is radical difference in representation between the vector Chinese characters for graphic plotters and the Chinese characters used on dot-matrix printers or CRT's. In dot-matrix representation for Chinese characters, the continuous strokes in a Chinese character are separated and dispersed to form a series of dots. When these dots are presented with a binary matrix of a specific size, the entire dot matrix information about this Chinese character is obtained. It is apparent that dot matrix representation of a Chinese character is more accurate with increasing matrix size. In order to obtain the vector representation of a Chinese character, the beginning and ending points for each stroke in the Chinese character have to be represented in coordinate form in a determined coordinate system. Generally speaking, the beginning and ending point coordinates can be directly determined for relatively regular strokes, thus obtaining the vector representation of the particular stroke, such as the horizontal stroke "—" and the vertical stroke "|". However, for some strokes whose variations are complex, multiple broken sections are needed in arriving at the vector representation for the stroke, such as the left-slanted vertical stroke " ╱ " and the right-slanted vertical stroke " ╲ ". Consequently, the number of strokes for vectorized Chinese characters are usually more than those for the actual Chinese characters.

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We set the beginning coordinate and the ending coordinate for a Chinese character stroke as (x_{oi}, y_{oi}), (x_{1i}, y_{1i}), then the total vector for a Chinese character is represented as

$$\sum_{i=1}^{N} ((x_{oi}, y_{oi}), (x_{1i}, y_{1i}))$$

where N is the number of strokes in the Chinese character.

The Chinese character library for graphics plotters in [1] is developed by a computer aided design system using a technology based on dot matrix analysis. The basic dot matrix used is 16x16, thus the vector coordinates for each stroke satisfy the condition

$$0 \le x_{oi}, y_{oi} \le 15$$
$$0 \le x_{1i}, y_{1i} \le 15$$

(1)

As we can see in the later part of this article, coordinate values having this kind of constraint will be a benefit for storage. For instance, the vectors for the two Chinese characters "Zhongguo" are represented in the Chinese library for graphic plotters in [1] as
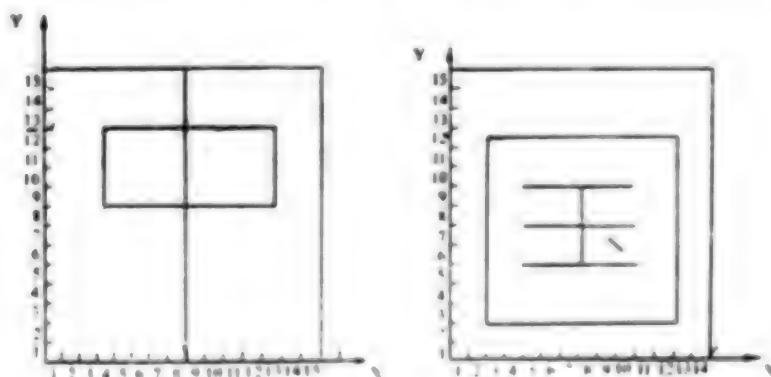
It can be seen that the vector representations for graphic plotter Chinese characters are vector coordinates for the Chinese character strokes. Data file construction for these vector coordinates using certain data structure will constitute the Chinese character library for graphic plotters. Because the vector coordinates in [1] meet Requirement (1), the X and Y values in each pair of coordinates can be represented in 8-bit bytes. Reference [1] stipulates that the upper 4 bits represent X ordinate and the lower 4 bits represent Y ordinate, thus the basic data structure for the Chinese character for graphic plotters is obtained as shown in the following figure.

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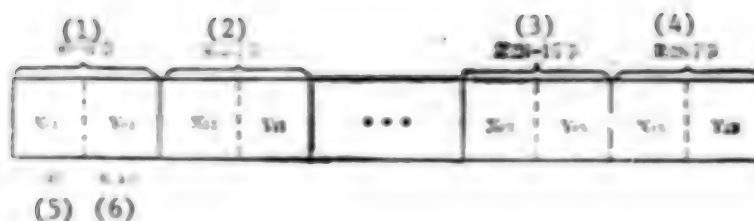
Key:
1. First byte
2. Second byte
3. $(2N-1)^{th}$ byte
4. $(2N)^{th}$ byte
5. The upper 4 bits
6. The lower 4 bits

It is apparent that for this kind of basic data structure based on graphic plotter Chinese character, the storage area occupied by all the vector information for each Chinese character varies. Intuitively, Chinese characters with greater number of strokes would occupy a larger area whereas Chinese characters with fewer number of strokes would occupy a smaller storage area. In this case, problems will arise in structuring storage for a Chinese character library for a graphics plotter.

In the dot matrix representation for Chinese characters, the storage size needed for a Chinese character is only related to the dot matrix size initially determined, but is not related to the number of Chinese character strokes. For instance, each Chinese character will need 72 bytes in 24x24 dot matrix representation or 128 bytes in 32x34, whereas it will not be so in the case for vector Chinese characters. For example, for the five strokes in "Zhong", 10 bytes will be needed according to [1], and for the 10 strokes in "guo", 20 bytes will be needed. With respect to this kind of data characteristic possessed by the vector Chinese characters, [1] employs a method based on the maximum of the average number of strokes in electing the length for data recording. The number of strokes are adjusted for Chinese characters exceeding this recording length so that the total number of strokes become less than the required data length. The recording length elected in [1] is 64 bytes, thus 32 strokes can be represented at the most, and this basically satisfied GB-2312 requirement for Chinese characters. The Chinese character library organized under this kind of storage structure has a size about 420 KB. The search speed is relatively high as this character library has to use a direct addressing method. However, there seems to be a great waste in storage space with this method, but in reality, many of the Chinese characters do not utilize 64 bytes, thus presenting a possibility for further compression.

3. The Paging Storage Method of Chinese Character Library for Graphics Plotters

There are various approaches in storage compression of vector Chinese character library for graphics plotters. The principle in our storage area compression is that the searching speed on character library, and the recovery quality on character form, will not be reduced. Any Chinese character can be broken down as the combination of various basic components. Only if the

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vector representations for the basis of sides and radicals are available, the vector representations for all the strokes in a Chinese character can be obtained using such transforms as lateral shift and proportion, and after character integration procedures. As the number of basic components in the Chinese character is much less with respect to the total number of Chinese characters, for a character library on which this method is applied, the storage space saving is very effective. However, the program to integrate basic components into composite characters is relatively complex, requiring more computer CPU time. In addition, the character form quality of the characters subsequently composed after recovery is not quite high. In actual computer aided design, enhanced graphic output speed as well as graphic quality are desired, without too much concern about some additional storage space. Therefore, the method of forming characters with radicals to compress storage does not appear to be an ideal method.

We may notice that, for the Chinese character library for graphic plotters presented in [1], there exist empty storage spaces of various sizes for each Chinese character data record. This indicates that the objective for maximum storage space utilization may be achieved if these Chinese character records could be organized, using the long records and the short records reciprocally. For instance, we have five records with the following data lengths (unit: byte):

44	58	48	64	54

According to the regulation in [1], the fixed storage space reserved for each data record is 64 bytes, then the actual empty spaces for each of the records are 20, 6, 16, 0, and 10 bytes, respectively. The total storage space wasted in these 5 records is 52 bytes. However, if these five records are stored in a data record with certain separation symbols, then the utilization rate of storage space for this record will be increased tremendously. Thus we propose a paging storage method for Chinese character library. Each page is set for certain storage space in which a certain number of Chinese characters can be stored. Thus the codes for each Chinese character will not be a one-to-one correspondence with the actual record location, but will be many-to-one correspondence instead. The actual search address of a Chinese character is determined by the record location corresponding to the code for this Chinese character--the page address and the address of this character in the page. The address of the Chinese character in the page is floating, and is determined by the number of strokes of the character in front of this character. There are separation symbols among the Chinese characters. The address of the character in a page depends on the location of the separation symbol for the character. Because the vector coordinates for Chinese characters in [1] occupy a full byte, it is apparent that one byte is inadequate to be used as a separation symbol between character data. The Chinese character separation symbol now used is two contiguous spaces "⌣", with a code "0 0" in ASCII standard. Thus, the Chinese character storage structure in a page is shown as the following diagram

									...		

As for the selection for page space size and the setting of a number of
Chinese characters in a page, they have to be determined based on the com-
plexity in the strokes for the Chinese characters stored. The principle
should be minimizing the empty space in a page while ensuring the storage
capability for all the Chinese character vector information specified
below. The Chinese character work symbol set specified in GB-2132 is
divided into two classes. The first class has a higher usage frequency,
and the strokes are relatively simpler, whereas the strokes in the Chinese
characters in the second class are more complex. The same paging size
requirement for these classes having Chinese characters with different
stroke characteristics will be obviously illogical. We require that, after
statistical calculation, the page for Class 1 characters will be 128 bytes,
storing 3 characters per page, and the page for Class 2 will be 255 bytes
storing 5 characters per page. The reason behind this selection is that
considerations based on statistics, also the maximum word symbol series
for a system is 255 bytes. Although the page utilization rate may increase
when a larger page is elected, but the difficulty in processing the word
symbols will be greatly multiplied. Based on this kind of paging process,
each character in Class 1 Chinese character will, on the average, use a
storage space of $128/3 = 42$ bytes, a reduction of 22 bytes, while the
storage space used for a Class 2 Chinese character is $255/5 = 51$ bytes,
a reduction of 13 bytes. The Chinese character library for graphics
plotters in [1] occupies a total storage space of 420 KB, as opposed to
310 KB by the Chinese character library using the paging storage procedure.
It is even more interesting to note that, two floppy disks were needed for
storage before, now the problem can be totally resolved with only one floppy
disk, evidence of the superiority of paging storage.

Naturally a question would be raised. Now that there exist in the Chinese
character library certain Chinese characters with 32 strokes or exceeding
the average number of strokes in a page, then, what will the process be if
these characters appear consecutively in a page? Because the Class 1
Chinese characters in GB-2312 are arranged by pinyin and Class 2 characters
are arranged by radical characters with relatively more strokes appear
randomly with an even distribution in Chinese character tables. Let us
assume that there are 200 characters having 32 strokes in Class 1 Chinese
characters, then, in page separation, the probability of consecutive occur-
rence in 1 page for 2 characters with 32 strokes is

$$P_1 = 0.0013$$

while the probability of consecutive occurrence for 3 characters with 32
strokes is

$$P_2 = 0.0005$$

indicative of the extremely low occurrence probability in reality. Even if this does occur, we still can adjust the strokes, compressing them within the page space. It can be seen that in the Chinese character library after paging storage, the consecutive occurrence of the characters having relatively more number of strokes is extremely low.

4. Conclusion

Paging storage is a feasible and effective storage method for the graphic plotter oriented vector Chinese character. The determination of page separation, size and the number of characters in a page depends on the precise statistical analysis of the number of strokes for all vector Chinese characters. Therefore, further effort could be attempted to arrive at a method to determine the optimal page size and number of characters in a page, consequently performing further storage space compression for the vector Chinese character library.

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MICROCOMPUTER APPLICATIONS IN POLYMERIZATION REACTOR

[Article by Zhang Yanyuan [4545 1377 3293], Chemical Industry Institute,
Lanzhou Chemical Industry Company: "Microcomputer Applications in
Polymerization Reactor"; article received 2 December 1985]

[Text] In experimental research on synthetic rubber, the measurement of such
parameters as axial and radial temperature gradient distribution and clamp
inlet and outlet temperatures is very important for examining heat transfer,
mixing and other industrial amplifications. The measurement of these
parameters is generally done by the multiple point temperature recorders and
manual periodic recording and the data is of rather low precision. But using
a microcomputer for rotational automatic sampling and measurement not only
can improve the precision of the data and reduce human error, but also can
collect more data and thus provide more complete data for engineering analysis
of polymerization reactors. In our project we used a TMC-80 microcomputer
for automatic rotational checking of reactor temperature, pressure and
coolant inlet/outlet temperature processing parameters in an experimental
polymerization reactor in our institute.

I. Processing Parameters in a Polymerization Reaction

The polymerization reaction selected for this work was the batch reaction
process. The polymerization process parameters are: polymerization time
was 8-12 hours, reaction temperature was $75\pm2°C$, and reaction pressure less
than 8 kg/cm^2. Figure 1 shows the checking points of the polymerization
reactor. T_{01} is the control point for the internal temperature of the
polymerization reactor, T_{02} and T_{03} are used to measure the polymerization
reactor's axial and radial temperature gradient, and T_{04} and T_{05} are used to
measure the temperature of the coolant at the entering and exit clamp.

II. Composition of the Microcomputer System

We used a TMC-80 microcomputer. The computer includes a Z-80A central
processing unit, 16K RAM memory element, and has a 16-path analog input (10
place digits), 8-path analog output, and parallel input/output channel PIO
port and serial input/output channel SIO port, 16-point switch input and

32-point switch output. It also has a television screen display (CRT), and an 80 column printer.
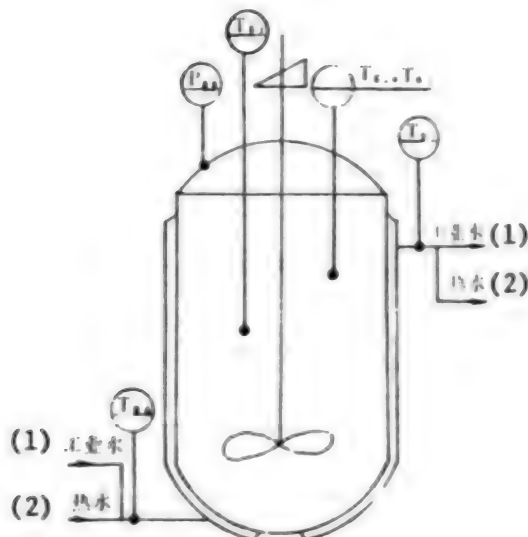
Figure 1. Checking Points of Polymerization Reactor

Key:
   1. Industrial water
   2. Hot water

III. Program

The program is written in Z-80 assembly language, and is compiled into machine code for execution. Under the control of a unified interrupt time service sub-program, it carries out rotational checking of the necessary checking points and carries out rapid and slow display on the CRT. At fixed intervals it prints. Figure 2 is the overall program block diagram.

The characteristic features of the sub-programs in the overall program are:

1. The sampling filter sub-program takes six samples at each point, filters out the maximum and minimum values, then takes the average of the remaining four values and uses that as the sample value.

2. During engineering conversion, the display sub-program intentionally enlarges the data by 100-fold, thus in the conversion of the displayed values they can be 3-place decimal numbers with two places after the decimal point.

3. The print sub-program prints out the data displayed on the CRT at fixed intervals. Actual print examples are as follows:

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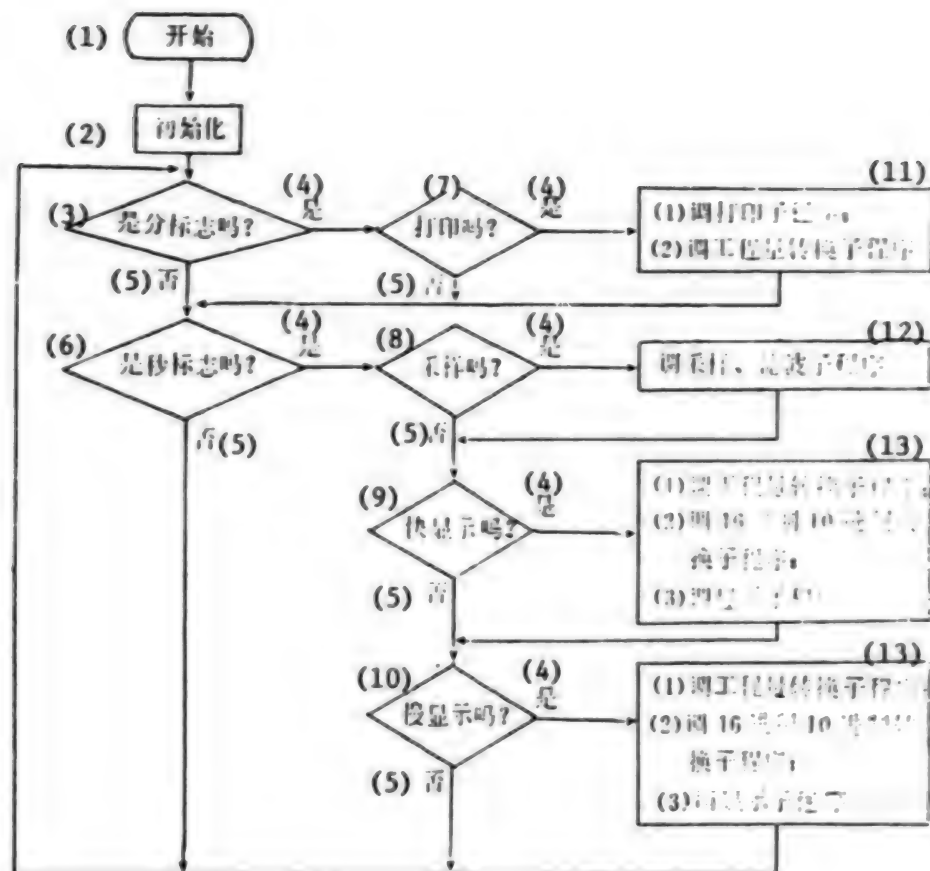
Figure 2. Overall Program Block Diagram

Key:
1. Start
2. Initialization
3. Minute marked?
4. Yes
5. No
6. Second marked?
7. Print?
8. Sample?
9. Fast display?
10. Slow display?
11. (1) Call print subprogram
    (2) Call engineering conversion subprogram
12. Call sample and filter subprogram
13. (1) Call engineering conversion subprogram
    (2) Call hex-decimal conversion subprogram
    (3) Call display subprogram

1985.06.21.12:55:00

00	T_{01}	T = 076.34
01	T_{02}	T = 072.62
02	T_{03}	T = 078.78
03	T_{04}	T = 022.09
04	T_{05}	T = 069.30
05	T_{06}	T = 000.58
06	T_{07}	T = 000.48
07	T_{08}	P = 007.92

1985.06.21.13:00:00

00	T_{01}	T = 076.63
01	T_{02}	T = 072.53
02	T_{03}	T = 078.98
03	T_{04}	T = 024.34
04	T_{05}	T = 081.23
05	T_{06}	T = 000.58
06	T_{07}	T = 000.48
07	T_{08}	P = 007.62

IV. Conclusion

1. The flexibility of using the TMC-80 microcomputer for carrying out auto-
matic rotational checking in intermediate test polymerization reactor is
considerable and it can adapt to variable industrial conditions.

2. Precision of the data can be as small as two decimal places, effective
values are as small as one decimal point, and trends in changes of parameters
can be clearly displayed.

3. On-site measurement signal can be converted to a unified 0-10 milliampere
signal, and reconverted to a 0-5 volt signal and input to a computer, and
this ensures the anti-interference capability of signals transmitted over
long distances.

NATIONAL STANDARDS FOR NOMENCLATURE OF SYNTHETIC RUBBERS

[Text] Editor's note: In China's national standards GB5576-85, a unified
nomenclature for synthetic rubber was proposed. In view of the fact that
the nomenclature principles are widely used in technical documents or indus-
trial materials, and that these standards will be put into effect beginning
1 August 1986, this journal is now publishing part of the formal document to
promote their thorough implementation.

These standards are suited to the nomenclature of synthetic rubbers. These
standards replace the nomenclature of enterprise synthetic rubber products
and should be used in technical documents or explanations.

The classification and code stipulations of these nomenclature standards are
primarily based on national standard ISO1629-1976(E), and codes are proposed
for synthetic rubber products which are not included in these national
standards.

1. Nomenclature Method

Classification and coding on the foundation of polymer chain chemistry
composition are as follows:

M   rubber which has polymethylene type saturation chains.

N   rubber containing nitrogen in the polymer chain.

O   rubber containing oxygen in the polymer chain.

R   rubber containing unsaturated carbon, such as natural rubber and a
        very small part of synthetic rubber manufactured from allenes.

Q   rubber containing silicon in the polymer chain.

T   rubber containing sulphur in the polymer chain.

U   rubber containing carbon, oxygen and nitrogen in the polymer chain.

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2. Class Names

2.1 "M" class rubber which has polymethylene type saturated chains uses the following classification method:

ACM   copolymers of ethyl acrylate and other acrylic esters and small quantities of monomers which can accelerate vulcanization.

ANM   copolymers of ethyl acrylate and other acrylic esters and acrylonitrile.

CM   polyvinyl chloride.

CFM   polytrifluorochloroethylene.

CSM   chlorosulfonated polyvinyl.

EPDM   ternary copolymers ethylene, propylene and allene. Remaining unsaturated chains containing allene in side chains.

EPM   ethylene-propylene copolymers.

FPM   polymer chain-bearing fluorine and fluor alkyl or fluor alkyl substitute rubber.

EPNM   polymer chain-bearing linjing [4340 5187] structures and fluor alkyl substitute rubber.

IM   polybutene.

2.2 "O" class rubber containing oxygen in the polymer use the following classification method:

CO   juhuanyanglubingwan [5112 3883 8638 3048 0014 7909 poly-epoxy-chloro-propane?] (lumi [3048 5721 chlorine-ether?] elastomer)

ECO   copolymers of ethylene oxide and huanyanglubingwan [epoxy-chloro-propane?]

GPO   copolymers of huanyangbingwan [3883 8638 0014 7909 ethylene dioxide?] and allyloxy glycide ether.

2.3 "R" class is defined by writing before the word "rubber" the name of one or several monomers of the rubber (with the exception of natural rubber), the letters directly in front of the letter "R" refer to the allene of the rubber so created (except for natural rubber). One or several letters in front of the allene letter refers to one or several copolymer monomers. The "R" class uses the following classification method:

ABR   acrylic acid-butadine rubber.

BR   butadine rubber.

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CR   cholorprene rubber.

IIR   butyl rubber.

IR   isoamyl rubber (synthetic).

NBR   butadiene-acrylonitrile rubber.

NCR   acrylonitrile-chloroprene rubber.

NR   isoamyl rubber (natural).

PBR   butadiene-vinylpyridine rubber.

SBR   butadiene-styrene rubber.

SCR   styrene-chloroprene rubber.

SIR   styrene-isoprene rubber.

NIR   acrylonitrile-isoprene rubber.

PSBR   butadiene-styrene bi [0070 pryidine?] rubber.

Note: hydroxyl rubber is classified under the class prefixed with an "X".

2.3.1 Polymer chain-bearing hydroxyl acid substitutes (COOH) are classified as follows:

XSBR   hydroxy butadiene-styrene rubber.

XNBR   hydroxy butadiene-acrylonitrile rubber.

2.3.2 Rubbers containing halogens in the polymer chain are classified as follows:

BIIR   butyl bromide rubber.

CIIR   butyl chloride rubber.

2.4 The "Q" class is defined by writing the name of the polymer chain-bearing substitute in front of the symbol for silicone rubber. The "Q" class uses the following classification method:

MFQ   polymer chain-bearing methyl and fluorine substitute silicone rubber.

MFVQ   polymer chain-bearing fluorine and methyl, ethenyl substitutes silicone rubber.

MNVQ   polymer chain-bearing methyl, acetonitrile group and ethenyl substitutes silicone rubber.

MPQ   polymer chain-bearing methyl and phenyl substitutes silicone rubber.

MPVQ   polymer chain-bearing methyl, phenyl and ethenyl substitute silicone
        rubber.

MQ   only polymer chain-bearing methyl substitute silicon rubber, for
        example poly-dimethyl siloxane.

MVQ   polymer chain-bearing methyl and ethenyl substitutes silicone rubber.

2.5 "T" class includes rubber containing sulphur in the polymer chain.

2.6 "U" class includes rubber containing carbon, oxygen and nitrogen in the
polymer chain and uses the following classification method:

AFMU   tetrafluoroethylene-trifluoronitrosomethane and nitroso-perchlor-
        butyric acid ternary copolymers.

AU   polyester ju'anzhi [5112 8637 7927 poly amino ester?] rubber.

EU   jumi ju'anzhi [polyether poly amino ester?] rubber.

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COMPUTERIZED ENGLISH, CHINESE DICTIONARY DESCRIBED

[Article by Lin Qiang [2651 1730], Wang Changhui [3769 2490 6540], and Liang Beihan [2733 0554 3352]: "Computers and the English Language; A Practical Computerized English-Chinese/Chinese-English Dictionary"; paper received in May 1986; first paragraph is source-supplied abstract]

[Text] Abstract: Efforts are continuing in the exploration of computer applications to language research. Although it is the intent of the "Practical Computerized English-Chinese/Chinese-English Dictionary" to pave the way for further attempts at computerized translation, we can say of the dictionary itself that it also has practical value even now. This paper briefly summarizes the characteristics of the computerized dictionary, and also serves to describe its structure, function, and prospects.

I. Preface

The birth of the computer and the development of its technologies has given rise to an extremely far-reaching effect on life in human society. This is especially true for the large volume production and general use of the micro-computer, whose rapid calculations, accurate memory, large storage capacity, and multiple functions have freed people from onerous, complicated routine labor in which they have engaged for a long period.

In the practice of teaching the English language, we have often encountered the following problems:

In looking for the Chinese meaning of a single English word we must consult an English to Chinese dictionary, while to find an English word corresponding to a Chinese single word, we must then use a Chinese to English dictionary. Would it be possible to use the same dictionary to find both English and Chinese words?

In compiling teaching materials, the arrangement of word lists is an onerous and arduous task because 1) single words must be arranged in alphabetic order;

2) you want to add phonetic symbols and parts of speech, but there is no way
for typewriters to type phonetic symbols, and there are even many printing
departments that do not have phonetic symbol fonts; 3) you want to give clear
indication of the corresponding Chinese meaning, but then you need a Chinese
language typewriter, etc. Could just one device could be used for this series
of processes?

When listening to English language news broadcasts, there are usually some
unfamiliar words that prevent an understanding of the complete meaning.
Because there are no concrete representations of the words, it is difficult to
find those words in ordinary dictionaries. Would it be possible to find the
word and meaning according to one's impression of the sound?

At the same time, with the broader use of the English language, translation
from Chinese into English has become a commonplace activity. Would it be
possible to imagine the computerization of English grammar and
dictionaries that would bring some simple mechanization and standardization to
ordinary translation? Look at the following sentence for example: "Ta zai
yingyuxue zhong yijing qudele hen dade jinbu." In view of the structure of the
entire sentence, would it be possible for a computer to 1) pick out the
nominative 'he' from the 'he' and 'him' as provided from a computerized
dictionary in accordance with the instructions of the computerized grammar;
2) place the prepositional phrase "in English study" at the end of the
sentence as is the custom in English; 3) choose 'has' and 'made' in accordance
with the rules for the perfect tense structure "have/has + Ved" and
singular/plural and irregular verbs; 4) come up with "He has made great
progress in English study" in accordance with the adjective 'great' as an
attribute and 'progress' as an indeterminate noun acting as an object, both
provided by the computerized dictionary. So, are these things possible?"

In an attempt to solve the problems just outlined and to open up prospects for
translation by computer, we have used the characteristics of the computer in
compiling the "Practical Computerized English-Chinese/Chinese-English
Dictionary" as a preliminary inquiry.

II. The Structure of the Dictionary

At present, the IBM PC-XT microcomputer is widely used in China, and we used
as well the Chinese character versions of dBASE II and dBASE III for all
management work. We also used the IBM PC-XT microcomputer and Chinese
character dBASE III to construct the computerized English-Chinese dictionary.

A. Input of International Phonetic Symbols

On the ordinary computer keyboard or English language typewriter keyboard
there are no input keys for the international phonetic symbols. In order to
enter English language international phonetic symbols, we modified the
character matrix base of CCDOS [Chinese character disk operating system],
which allowed convenient entry of international phonetic symbols directly from
the keyboard.

There are a total of 48 phonetic symbols for English. Aside from the original

English alphabet provided on the keyboard, we modified certain keys on the keyboard like so:

@——ɑ, $——ʃ, %——æ, ^——ʌ, /——ɛ, {——θ,

}——ʒ, ~——ŋ, '——ə, ¦——ɔ, \——ð.

As far as the English-Chinese dictionary is concerned, the original character matrices of these keys are not used or are seldom so. After the modifications, entry of international symbols is quite easy, and it neither affects the operation of dBASE III nor does it make the modified CCDOS into a system program exclusively for the computerized dictionary.

It must be pointed out that after installing the international phonetic symbols in the CCLIB file, it is not appropriate to then enter international symbols using the Chinese character matrices. For phonetic symbols and the English language alphabet formed in this way, whether displayed or printed out, the sizes of the character forms are obviously not coordinated, entry is not convenient, and more memory is taken up.

B. Construction of the Database Files

As of this date, we have constructed several database files, which have been stored on the hard disk.

1. English-Chinese Dictionary Base

The structure of the English-Chinese dictionary base is:

Field	Field name	Type	Width (decimal)
1	serial number	character	1
2	word	character	30
3	phonetic sym.	character	22
4	part of speech	character	7
5	Chinese word	character	40
6	usage & example	memo	10
Total			111

We have selected and entered more than 20,000 items of common words and phrases. Regarding the common verbs, we have paid special attention to verb phrases and their usage, and we have also used examples for illustration.

2. National Materials Base, Organizations and Structures Base

We have collected simple materials from more than 100 countries to establish a national materials base, the structure of which is:

Field	Field name	Type	Width (decimal)
1	continent	character	10
2	continent English name	character	15
3	phonetic symbol 0	character	20
4	abbrev. country name	character	20
5	English abbrev.	character	24
6	phonetic symbol 1	character	25
7	full country name	character	30
8	full Eng. country name	character	56
9	capital	character	20
10	capital English name	character	20
11	phonetic symbol 2	character	20
12	Chinese title	character	20
13	national title	character	20
14	phonetic symbol	character	20
15	population	numeric	12

Total   333

We also built an organizations and structures database, into which we have
entered the English names for international diplomatic structures and the
structures at all levels in China. That database is structured as follows:

Field	Field name	Type	Width (decimal)
1	structure's English name	character	80
2	structure's Chinese name	character	60

Total   141

3. English Proverbs Base, Cultural Knowledge Base

In order to help in the look up of English proverbs as well as English phrases
of specialized "cultural knowledge," we have built an English proverb base and
a cultural knowledge base.

The structure of the English proverb base is as follows:

Field	Field name	Type	Width (decimal)
1	English proverb	character	50
2	Chinese meaning	character	100
3	close Chinese saying	character	30

Total   167

The structure of the cultural knowledge base is as follows:

Field	Field name	Type	Width (decimal)
1	English phrase	character	50
2	Chinese meaning	character	100

Total   .   151

In addition to these, we have also built a base for irregular verbs, into
which we have entered more than 300 irregular English verbs for ease in
looking up. The structure of this database is as follows:

Field	Field name	Type	Width (decimal)
1	verb infinitive form	character	15
2	past tense	character	25
3	past participle	character	30

Total   71

We will gradually expand the records in each database, which will make the
glossaries even richer. At present, the databases files just described occupy
6 MB on the hard disk.

C. Command File

For various kinds of look-up, we have build a command file menu with various
subroutines.

The command file main menu is:

```
CLEAR
SET TALK OFF
REST FROM C:ABC
I=1
J=3
DO WHILE I<=J
? "Please enter password: "
SET CONS OFF
ACCE TO PA
IF PA <> SS
SET CONS ON
? CHR(7) + CHR(7) + CHR(7) + "password error!"
STOR I+1 TO I
IF I=4
QUIT
ENDIF
LOOP
ENDIF
STOR 4 TO I
ENDDO
SET CONS ON
STOR "Y" TO PASS
```

```
DO WHILE UPPER(PASS)="Y"
CLEAR
?"**************************************************************************
?"*                                                                        *
?"*              This software has the following functions:                *
?"*                                                                        *
?"*  1 = English to Chinese look up      2 = Chinese to English look up *
?"*  3 = Edit Chinese-English dictionary  4 = Edit password              *
?"*  5 = Quit                                                             *
?"*                                                                        *
?"**************************************************************************
?"
?"     Please enter choice 1, 2, 3, 4, or 5"
WAIT TO L
DO CASE
CASE L="1"
DO D1
CASE L="2"
DO D2
CASE L="3"
DO D3
CASE L="4"
? "Please enter new password"
RELE ALL
ACCE "new password" TO SS
SAVE TO C:ABC
CASE L="5"
PASS="N"
ENDCASE
ENDD
CANC
```

We have modified the AUTOEXEC.BAT file. After initializing the host power source, the CRT will display:

    Enter password: (where the CRT does not display the entered password)

After responding to the password, the CRT will display the entered selection and execute various look-ups. If the password response is in error 3 times, the program returns to its DOS state.

A. English to Chinese Look-up

When entering the English-Chinese look-up, the CRT will display:

```
*******************************************************************
*                                                                 *
* The function of this program is to look up from English to Chinese *
*                                                                 *
*   1 = look up an English word      2 = look up homophonous English *
*                                        word                     *
*   3 = add to English glossary      4 = look up an English proverb *
*   5 = look up a country, capital   6 = cultural knowledge look-up *
*   7 = look up irregular verb       8 = quit                     *
*                                                                 *
*******************************************************************
```

Please enter choice 1, 2, 3, 4, 5, 6, 7, or 8

At this time, one can enter English words, phonetic symbols, word groups,
English sayings, and the English names for countries or capitals, as well as
special "cultural knowledge" and English phrases for look-up. If the word or
word group is found, the corresponding word, phonetic symbol, part of speech,
Chinese rendition, usage, and an example are displayed, and this may also be
printed out. If the look-up is not successful, a phrase to that effect is
displayed. If a word or word group has many usages or interpretations, these
will be listed one by one.

After look up of a word, by responding to the machine with a 'Y' or an 'N',
the user may continue to look up words or may exit.

B. Chinese to English Look-up

When entering Chinese to English look-ups, the CRT will display:

```
*******************************************************************
*                                                                 *
*       This program is for looking up Chinese from the English   *
*                                                                 *
*  1 = Enter Chinese to look up the    2 = Enter Chinese to look up *
*      the English word                    the English phrase      *
*  3 = Enter Chinese to look up the    4 = Use Chinese to look up    *
*      English proverb                     countries and capitals   *
*  5 = Exit                                                        *
*                                                                 *
*******************************************************************
```

Please enter choice 1, 2, 3, 4, or 5

By entering Chinese, one can look up English words (or phrases), as well as
phonetic symbols, parts of speech, usage, and examples. By entering Chinese
or Chinese sayings, one can find English sayings of a similar meaning. By
entering the abbreviated Chinese name for a country or a capital, one can find
some simple information about this country. Results from look-ups may be
printed out at any time.

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Upon completion of a look-up, use 'Y' or 'N' to respond to the computer prompt, and one can continue with further look-ups or may exit.

C. Revision of the Dictionary

Data revision for a dBASE III database is extremely easy. We have provided a subroutine such that when the choice is made to revise, the CRT will display:

```
***************************************************************************
*                                                                         *
*        This program is for revising the Chinese-English dictionary      *
*                                                                         *
*        1 = insert a new entry             2 = add a new entry           *
*                                                                         *
*        3 = delete an entry                4 = revise an entry           *
*                                                                         *
*        5 = no more revision, exit                                       *
*                                                                         *
***************************************************************************
```

                    Please enter choice 1, 2, 3, 4, or 5

One can choose to do various sorts of revision.

When the revision is completed, the computer will automatically update the various index files.

D. Password Revision

It is very easy to revise an encoded password. When it is necessary to do so, one only needs to enter the revise password state and enter the new password. The computer will automatically accomplish the revision.

Software such as the computerized English-Chinese dictionary and the command files may be used on the IBM PC-XT and compatibles. Installation of the software is quite easy, and the programs are complete.

III. Applications

1. English-Chinese and Chinese-English Look-ups

The computerized dictionary is capable of complementary look-ups, that is, by entering an English word one can look up the Chinese meaning, and by entering Chinese words one can look up the English meaning. For example, if we were to enter 'insist', just by entering 'insist' the illuminated display will show its spelling, phonetic symbols, part of speech, the Chinese equivalent, usage, and examples:

word: insist   phonetic symbols: [in'sist]   part of speech: V.

Chinese: [to insist, to advocate resolutely]   usage: insist on/that

examples: I insist on your speaking English.
           He insists that he is innocent.

When using Chinese to look up English, one need only enter the Chinese
expression, and then all English words having this Chinese meaning will be
displayed. Then, through comparison and differentiation one may choose the
most appropriate English word. For example, if one entered "faguang" he would
see: 单词 dazzle: 汉语 发光，眩目，眩惑；

              gleam: 汉语 发光，发闪光，发微光；

              glitter: 汉语 闪闪发亮，闪烁，发光；

              glow: 汉语 灼热，发光，（余热）；

              shine: 汉语 发光，放光，照耀；

              sparkle: 汉语 发火花，发光，闪耀，（酒）发泡.
There is an corresponding sentence after each English word.

2. Looking up Single Words Through Phonetic Symbols

If you enter into the computer the sounds you hear by means of the
international phonetic symbols, you can find the corresponding English words
and their Chinese meaning. For example, if you enter the [['tʃekəusləu'vækiən]
that you have heard, you will see on the illuminated display:

              单词 Czechoslovakian   音标 ['tʃekəusləu'vækiən]

              词类 a. n.   汉语 捷克斯洛伐克的（人）.
Sometimes, there will be a situation where the same sound produces several
different words, as for example when you enter [teil], which will produce
'tale' (story) and 'tail'. In this situation, one can usually make one's
choice through context.

In addition, at the same time as this provides homophonic multiple word
practice in English language teaching, selection can be made through the
computerized dictionary, and it is both easy and quick.

3. Verb Phrase Look-up

If one encounters a verb phrase not understood, there is no need to first seek
the verb in a regular dictionary, only then to find its collocated adverbs and
prepositions. It is only necessary to directly enter the verb phrase, after
which one may find its accurate meaning, usage, and examples. For example,
enter "put up with," for which one will find:

              put up with 容忍，不计较，迁就；

              例句 She can't put up with her husband.

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4. Searching for Parts of Speech

If one were to encounter a sentence such as "There are cars not of all makes on the road" and must look up the correct meaning of 'make,' one may determine its part of speech in accordance with its grammatical function in the sentence. Enter "make," then add an 'n' (for noun), and one will see:

单词: make,　　　词类: n,　　　汉语: 制造(法), 样式

because of which one need not waste time and energy in searching for the verb components.

5. Creating the Vocabulary List

When making the vocabulary list, one need only enter all words in accordance with topics that are to be used, and the computer will automatically accurately alphabetize them, clearly state the phonetic symbols, parts of speech, and Chinese version, and will create a report format, after which it can be directly printed on stencil paper.

6. Other Look-ups

The computer has a great deal of storage capacity. Therefore, the computerized dictionary may collect from other reference materials as broadly as possible (for things such as countries, organizations and structures, etc.), which will make look-up more convenient. Sometimes we know only an abbreviation of a country or structure and not its complete name, or we only know its Chinese name and not its English name (the average dictionary does not have this material, and other materials must be consulted). At this time, one need only enter the abbreviation or the Chinese name and give the command to look up countries, and one will be able to find the complete English and Chinese names as well as its capital and population. Similarly, by entering "Zhonggong zhongyang duiwai lianluo bu" one will find the standard translation of "International Liaison Department of the CPC Central Committee."

At the same time, we have included English language proverbs and irregular verbs in the computerized dictionary. We know that the proverbs or sayings of a particular language are established by usage and cannot be changed arbitrarily. It is just as expressed in the Chinese saying "bu guan san qi ershi yi," where you cannot extend this to arbitrarily change it into "bu guan si ba ershi er." By looking it up, one may determine whether or not this is a common saying. If it is, one sees how it must be used in accordance with its original intent, and where it can be used appropriately.

In addition to this, we can find English language sayings from the Chinese sayings, as for example if you were to enter "yi jian shuang diao," you would discover the English language similar saying "killing two birds with one stone," which would improve the translation and the accuracy of the saying used.

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Regarding irregular verbs in the English language, the average small dictionary will seldom have these and provide lists of irregular verbs; larger dictionaries will include them, but will generally only state that they are the past tense or past participle of a certain verb, so if you need the meaning you will have to look up the basic form. The computerized dictionary shows all the forms and meanings on one screen, which allows one to understand at a glance.

IV. Conclusions

The goal in compiling the computerized dictionaries lies in using the characteristics of the computer to supplement the deficiencies of ordinary dictionaries, but at present they cannot completely replace regular dictionaries. The reasons for this are: 1) due to time restrictions, the contents of the computerized dictionaries are quite limited; 2) computers have yet to enter the home in China. However, even at present, the computerized dictionaries have a definite significance, whether in libraries and materials offices or in the teaching and learning of English, as well as teaching aides.

In addition, as soon as regular dictionaries are printed they become difficult to revise. But the computerized dictionaries are characterized by an ability to be revised or supplemented at any time, and especially to be supplemented.

It is our belief that as time passes and as the computer becomes more common, computerized dictionaries will improve progressively and will find favor with people.

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CALCULATIONS OF NEUTRON SKIN FOR SPHERICAL NUCLEI USING HARTREE-FOCK METHOD
WITH SKYRME FORCES

[English abstract of article by Ye Weilei [0673 5898 4320], et al., of Hangzhou
University; Zheng Chunkai [6774 2504 7030], et al., of Beijing University;
Tian Ye [3944 6851], et al., of the Institute of Atomic Energy, Beijing]

[Text] In this paper the neutron skin for spherical nuclei is discussed using
the Hartree-Fock method with Skyrme forces. The density distributions and the
root-mean-square radii of the protron and neutron, and the thickness of the
neutron skin for symmetric and asymmetric spherical nuclei are calculated
using four sets of Skyrme parameters: S II, S III, GS2 and SKa. The calculated
root-mean-square radii of the proton and neutron are in agreement with the
experimental values. The calculated results of the thickness of the neutron
skin show that there are neutron skins for asymmetric spherical nuclei, but no
neutron skins for symmetric nuclei. The theoretical calculations are in
agreement with the experimental results. For comparison the calculations
are also done with a nuclear macro-model, and similar conclusions are obtained.

9717
CSO: 4009/46

TRANSPORT MODEL FOR STUDYING HEAVY NUCLEUS FISSION

[English abstract of article by He Zejun [6320 3419 0689], et al., of the
Institute of Nuclear Research, Chinese Academy of Sciences, Shanghai]

[Text] Using a mathematical model potential as the fission barrier, the
fission rate of ^{236}U is calculated from the Fokker-Planck equation by means of
a complex matrix continued fraction method. The maximum fission rate at a
certain viscosity coefficient is also obtained by studying the dependence of
the fission rate on the nuclear viscosity. Comparison with results obtained
by using Kramers' formula shows that the authors' model can give a better
description of the heavy nucleus fission.

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SMALL ANGLE ELASTIC SCATTERING OF 14.2 MeV NEUTRONS BY ^{238}U

[English abstract of article by Li Jingde [2621 2529 1795], et al., of the Institute of Nuclear Science and Technology, Sichuan University, Chengdu]

[Text] The elastic scattering differential cross section of ^{238}U of a 14.2 MeV neutron is measured for scattering angles within the range of 1.7° to 15°. The corrections for neutron fluence attenuation, multiple scattering and finite geometry are performed by the Monte-Carlo method. The experimental results are compared with the available data from other works and the theoretical calculation. The nuclear cross sections did not rise as sharply toward 0° as they did in earlier measurements. There are no "anomalies" in the shape of the angular distributions at small angles. The nuclear cross section extrapolated to 0° is compared with the Wick limit.

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CSO: 4009/46

MEASUREMENT OF SECONDARY NEUTRON SPECTRA FROM ^{238}U INDUCED BY 14.2 MeV NEUTRONS

[English abstract of article by Shen Guanren [3088 0385 0088], et al., of the Institute of Atomic Energy, Beijing]

[Text] Secondary neutron energy spectra from ^{238}U induced by 14.2 MeV neutrons are measured using an associated particle time of a flight spectrometer. The neutron flight path is 3.055 m. The neutron detector threshold is 1.75 MeV. The time resolution is about 1.2 ns. The double differential cross sections in the effective energy range of 2 to 12 MeV are measured at 13 angles in the range of 15° to 155°, with an overall error of 5-15 percent. The experimental results are corrected for neutron fluence attenuation, multiple scattering and finite geometry by means of the Monte-Carlo method and are compared with nuclear theoretical calculations, producing good agreement.

NETWORKED MANAGEMENT INFORMATION SYSTEM DEVELOPED

[Article by Zhu Mingxue [2612 7686 1331], Yong Zhengzheng [7167 2973 2973], Xu Qiusheng [1776 4428 3932], Chen Jinhua [7115 6855 5478], and Li Zhouguang [2621 1352 0342]: "Design of a Microcomputer Local Area Network Management Information System"; paper received June 1986]

[Text] Abstract

This paper describes in some detail the hardware selection and configuration for a microcomputer local area network management information system as well as the structure and primary functions of the applications software for this system.

I. Introduction

The new-technology revolution has pushed human society toward a new scientific era. Information is an important resource for this new era. Timely collection, collation, and use of relevant information and opportune and sensible decision making are important demands on modern management personnel. And the essential function of the computer in modern scientific management has become an acknowledged fact. With the dissemination of the microcomputer and the development of software tools, development of computer application projects has become easier and easier, growing constantly in intensity and scale. Development from single-machine, single-task applications in the direction of multiple machines in networks or multiple terminal systems is one index of constant improvement in the level of contemporary computer application development.

Recently, with the support and aid of tax-exempt companies in Shenzhen City, we designed a microcomputer local area network (LAN) management information system, which on a network composed of several machines has made beneficial exploration in the areas of data sharing and information exchange. Although this system is still at the initial stage of management information systems, during operations over several months, it is still showing certain advantages regarding the use of microcomputer LAN's as tools for managing information and processing data.

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II. System Hardware Selection and Configuration

Before we determined the system configuration, we made a broad study,
repeatedly testing and comparing, and from a multitude of selection plans we
chose the high-performance microcomputer Ethernet technology. Its primary
characteristics are:

1. The system may be divided or combined, it is easy to install and easy to
maintain, and even when there are faults in the service, all terminals may
work independently and will not individually cause a cessation of operations.

2. The network may be formed with the widely used IBM PC (XT), and the quite
mature Chinese character operating system and Chinese character database manage-
ment system can operate in the network without modification. This greatly
reduces the amount of work needed for software development and attendant
expenses and reduces the time needed for development.

3. We chose thin-cable Ethernet products and the reliable IBM PC (XT) compati-
bles as terminals, which allowed for a great reduction in the system's cost.
The rate of transfer for the network is as high as 10 mbps (million bits per
second), which is quite sufficient for general management systems without a
great need for real-time tasking.

4. The network server storage space may be expanded to more than 100 mega-
bytes, which when added to the storage space of the terminal PC XT allows a
total storage area of nearly 200 megabytes. This should be sufficient for
a mid-range management system.

5. System expansion is easy, requiring only the addition of an Ethernet board
to a PC, which allows connection with the network.

Based on real applications by the tax-exempt companies, the final system
configuration as determined is shown in the following figure:
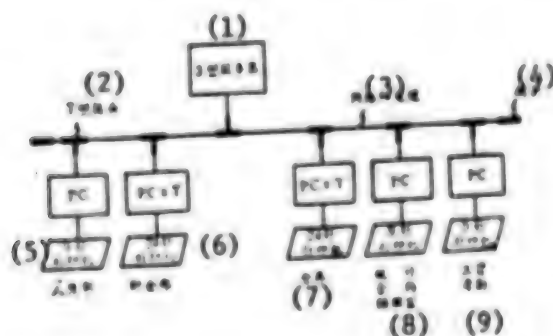
[Key on following page]

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Key:
1. Model 3 server
2. T-connector
3. Network fine cable
4. Terminus
5. 9-pin dot matrix printer
    Personnel Security Department
6. 24-pin dot matrix printer
    Accounting Department
7. 24-pin printer
    Warehouse
8. 9-pin printer
    Statistics, Contracts Allocation
9. 9-pin printer
    Wages, Attendance

In order to meet the demands from a multitude of terminals and a large number of printed reports, each terminal in the system is configured with a printer. When terminals configured with 9-pin printers need to print out high-quality reports, they will be transferred to terminals fitted with 24-pin printers through Model 3 servers.

III. Structure and Functions of Application Software

As far as a terminal user is concerned, efforts to change application software into Chinese characters are very important. But we have discovered in actual use that for a system that has already been installed, only when terminal users initialize the system can they use certain network-operating commands. Because of this, we have made the initializing commands into files, which allows for automatic execution after start-up and erases some files on the Ethernet/ DOS boot disk. This brings things into compliance with the widely used CCDOS of the Sixth Institute of the Ministry of Electronics, generates a Chinese character Ethernet boot disk, and allows the workstation to be placed directly into an environment of Chinese character operations after boot-up, that is, where Chinese character files may be input/output and processed on the network. All application software is then supported by CCDOS, which allows for the creation and execution of statements and commands for dBASE III using Chinese characters in the database management system.

The system is composed of six components, which are financial management, warehouse management, contract management, wages and attendance management, personnel files management, and statistical reports management. The structures and characteristics shared by these application software packages are:

1. A basic database that reflects actual applications as completely as possible. Under control of a uniform database management system, with the least possible data redundancy, and with the prerequisite of ensuring security and limited access, these features can provide the conditions for the greatest possible degree of data sharing.

2. A convenient management system for doing maintenance operations on the basic database. These functions include: adding records, deleting records, revising records, and searching for records. Definite recoverability has been provided for such operations as deleting. In addition, all operatio done with padding, with prompts from screen lists.

3. A group of user-oriented interactive application programs. Their primary functions include searching, statistics, and reporting. By determining the

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usage authority and usage scope that corresponds to the status of a user, these
application programs ensure the integrity of the data. All operations are
screen menu driven, and prompt the user to enter some numbers or letters through
which operations are undertaken, which allows users who have no special train-
ing in computers to learn to use this system quickly.

4. By use of the hierarchical modular structured programming design methods,
this system has excellent expandability, readability, and ease of maintenance.

Aside from these shared functions and characteristics, in accordance with
application needs some special functions have been designed into the various
function modules:

A. Financial Management

The traditional accounting operation process is done in terms of the sequence
of accounting entries, separate records are kept in accordance with loan rules
and regulations, and charges and evidence are recorded. After that, charges
and evidence are entered one by one into detailed accounts, which are collected
together within a specified time period, and the results of that collection are
entered into the general ledger. Accountants must write reports each month,
quarter, and year on the basis of clear itemized accounts or general accounts.
This is extremely complex and detailed work.

To bring about the automation of accounting, we have written a set of programs
to simulate the manual accounting process. Aside from first step, that of
entering accounts and evidence from the originals, which is still done manually,
the remaining steps are all carried out automatically by the computer. This
accounting management system has the following characteristics:

- It is only necessary to enter the accounts and evidence, and the computer
will automatically do the calculations and generate detailed itemized accounts,
itemized reports, and general ledgers.

- When entering accounts and evidence, the computer will automatically verify
whether or not the loan has been balanced, and will strictly control the
accuracy of materials.

- It simplifies the monthly and yearly settling of accounts, for when the com-
puter balances the books, it is quick and accurate.

- Accurate financial reports may be provided at any time, reports such as fund
reports and operational conditions reports.

- Surpluses in itemized accounts may be investigated at any time for each
accounting item for which accurate information is rapidly provided.

B. Warehouse Management

For this there are the powerful features of automatic calculations and account-
ing as well as definite information feedback and warnings.

Screen formatted prompts may be used for the user to select input of a commodity check before delivery menu (enter warehouse menu), a commodity allocation and transfer menu (exit warehouse menu), a commodity pricing menu, and a commodity rise in consumption menu. At the same time, one may automatically print out some copies of the same documents to be given to different recipients, such as accounting offices, customers, warehouses, customs, and banks. And one can automatically calculate the newly stored quantities and values of stored goods, can revise warehouse storage reports, and can enter commodities into itemized reports.

In accordance with the estimated daily quantities of outgoing materials, one may calculate the daily quantities of commodities for maintenance, and when the warehouse quantities exceed the greatest value for warehouse storage or are lower than minimum values, the system will automatically issue a warning and provide the warning information.

Two different quantity values are kept in the database, as for example "cases" and "items," and when the system is entering into or reading from the database, the systems can convert automatically between the two, thus always ensuring that the greater unit is stored and output.

Warehouse inventory reports and other statistical reports may be made at any time.

C. Contract Management

The contract management system can manage a large quantity of files containing letters of agreement, sales confirmation documents, and distribution contracts signed between the system user and customers. It can also promptly, conveniently, and accurately do various kinds of searches and statistics on contract summaries and detailed contents.

There can be a random input of recently concluded contract summaries and itemized provisions.

The contract conditions of execution that have already been entered may be revised, and when necessary, the provisions may be corrected. During the revision operations, by using the progressive editing method one may conveniently insert lines, delete lines, insert words, and delete words in the contents of contracts.

At any time, one may search for certain contract summaries, itemized provisions, or execution conditions that have been previously entered. When searching, one may search both for various fundamental conditions, such as the name of party A, the effective duration of the contract, the total value, etc., which may also be flexibly organized according to various basic conditions to meet the special needs of users.

There can be categorical statistics done for contract execution conditions already entered, and the results thereof may be printed out.

D. Wages and Attendance Management

This system module provides management services for the user regarding the
situations for unit monthly attendance and wage allocations, which services
are primarily characterizied by:

This module provides a logical database for various user viewpoints, allowing
the same physical database to have the functions of several logical databases.
This reduces redundant quantities of data and improves the security and complete-
ness of data.

This module provides powerful auxiliary means for report generation. Based on
need, the user can use the format-generating submodule to generate conveniently
the foremat needed.

This module provides a virtual printer. When there are insufficient high-
quality printers available to a user, this permits the user to store temporarily
the output format as text.

E. Personnel Management

In addition to the regular functions for searching and reporting that are
common to personnel files management, this system module has the following
characteristics:

It stores personnel files at different levels. The personnel files database
is divided into several databases such as a base of basic conditions, a base
of family situations, a base for social relations, a base for important
experience, a base for reward and punishment records, and a base for historical
problems. The basic conditions base is the primary database, while the other
bases are databases complementary to it. Only when the value of relevant fields
in the main database is "true" will there be records of this material in the
corresponding subdatabase, and otherwise there will be nothing in that record
space. If the value of the "historical problems" field is "yes" (or "true")
for a certain person in the main database, there will be material in the
records for this item stored in the historical problems subdatabase. Otherwise,
there will be no entry in the subdatabase. This greatly reduces the
redundancy of the database.

There is a certain capacity for error tolerance. User non-fatal error operations
will not affect the continuing execution of the program, nor will they harm the
data.

It established encoded passwords, which ensure access to and security of the
data.

F. Statistical Management

This is primarily for general statistics for main companies and for the
bringing in, selling, and storage conditions for commodities of branch compan-
ies and market operations. Large quantities of original data in statistics

come from different departments, and for this reason there is a need to access successively the relevant databases of these departments to gain necessary information from within them. For those departments that are not yet networked or are not yet using computers, this system has provided a convenient entry routine that through screen formats prompts the user to enter the corresponding data. Finally, after all data have been collected, the system will do its calculations and output a general statistical report.

Conclusions

The largest portion of system modules for this management system is already in operation, and we can see from several months of operation that although further modification and perfection are necessary, as far as overall functions are concerned, this system basically fulfills the design goals that had been set. Had this project been designed by certain companies outside China, the software development costs alone would have been 11 million Japanese yen, and the system budget would have been more than HK$1 million. But total investment in this system has been only HK$200,000. In comparison, we feel that a relevant management information system that is based on domestic applications development technology and uses microcomputer local area network technology will have advantages that cannot be ignored regarding practicality and economics, as well as in the areas of maintenance management and expansion of functions.

12586/9716
CSO: 4008/1062

POLARIZATION ANALYZING POWER FOR ELASTIC SCATTERING OF 2.7 MeV POLARIZED
NEUTRONS ON Pb

[English abstract of article by Chen Zemin [7115 3419 3046], et al., of the
Physics Department, Qinghua University, Beijing]

[Text] The angular distribution of the polarization analyzing power is
measured for elastis scattering of 2.7 MeV polarized neutrons on Pb. The
fast neutron polarimeter with associated time-of-flight systems is improved
to have lower experimental background and higher stability. The experiment
results can be used to test the discrepancies of previous experiment
results and increase the data of back angles in polarization experiments.
The optical model calculation program which can search the optical potential
parameters automatically is written. Finally, the measurement is compared
with optical model predictions, using known global potential parameters, and
the optical parameters are obtained.

9717
CSO: 4009/45

DETERMINATION OF γ-RAY ANGULAR DISTRIBUTION IN ^{197}Au(α, 2n)^{199}Tl REACTION

[English abstract of article by Liu Fengying [2692 7685 5391], et al., of the Institute of Atomic Energy, Beijing]

[Text] The angular distribution measurements of γ-rays in the ^{197}Au(α, 2n) ^{199}Tl reaction are carried out using a 26 MeV α particle beam from the cyclotron of the Institute of Atomic Energy. The angular distribution coefficients of the 11 intense γ transitions are measured. By the χ^2 fitting test, and based on the previously given spins and parities of low-lying levels of ^{199}Tl, the spins and parities of eight levels are assigned. The spin and parity of the level at 1984 keV is assigned to be $17/2^-$, with the key action on the determination of the positive-parity band-head and on the knowledge of the level at 2471 keV of ^{199}Tl. Its $13/2^+$ state assigned by the Berkeley group is denied, but the $15/2^+$ level at 2079 keV is confirmed as the positive parity band-head. The spin and parity of the 2471 keV level that was first measured by the authors in 1984 is assigned to be $19/2^-$. The negative parity band is extended from the previously obtained $15/2^-$ state to still higher spin states.

9717
CSO: 4009/45

DOUBLE Λ-HYPERNUCLEI AND EFFECTIVE INTERACTION Λ-Λ

[English abstract of article by Zhuang Fei [8369 2431], et al., of the Institute of Atomic Energy, Beijing]

[Text] The Hartree-Fock method is used to calculate the double Λ binding energies of double Λ-hypernuclei $_{\Lambda\Lambda}^{6}$He and $_{\Lambda\Lambda}^{10}$Be. The Sakaton (nucleon and Λ particle) single particle wave function used in the authors' H-F calculation is expressed as the linear expansion of the harmonic oscillator functions. The interactions between two Sakatons are taken to be of double Gaussian form. The N-N interaction is taken as Volkov interaction. The parameters for the Λ-N interaction are chosen from the authors' former paper. According to the qualitative analysis of meson exchange theory and by fitting the experimental values of the double Λ binding energy, the parameters for the Λ-Λ interaction are determined. The results show qualitatively that the Λ-Λ interaction is the weakest of the three effective interactions (i.e., N-N, Λ-N and Λ-Λ effective interaction) and the N-N interaction is the strongest.

9717
CSO: 4009/45

ELECTRON TRAJECTORY CALCULATION OF HIGH CURRENT RELATIVISTIC ELECTRON BEAM
DIODES

[English abstract of article by Du Shigang [2629 0013 0474] of the Institute
of Atomic Energy, Beijing]

[Text] This paper describes the computational method of electron trajectory
in high current relativistic electron beam diodes. The effects of the space
charge of the ions emitted from the anode plasma surface are included. It is
shown that the space charges and magnetic field of the ions play an important
role in obtaining strong electron beam pinching. The results obtained are
in agreement with the experimental results.

9717
CSO: 4009/45

ULTRASHORT DYE ASE PULSES GENERATED BY TRANSVERSE TRAVELING WAVE PUMPING

[Article by Li Wenchong [2621 2429 0394], Ning Changlong [1337 7022 7893], and Huang Zuozhu [7806 0155 2891] of Zhongshan University Physics Department; manuscript received 27 September 1985; first paragraph is source-supplied English abstract]

[Text] Abstract: An N_2 laser with λ = 337.1 nm and pulse width = 700 ps is used as a pumping source. Using a transverse traveling wave pumping apparatus, ASE pulses with durations of 45, 55, and 45 ps are obtained from dye solutions of Rh6G, RhB, and C311.

Amplified spontaneous emission (ASE) is an important effect in dye laser systems. Many researchers have studied it.[1-4] Discovered under high power density excitation, ASE in the medium gives very large increases in gain and beam directionality, the bandwidth narrows, and the width of the light pulse is slightly less than the pumping pulse width.

We used an N_2 laser (pulse width 0.7 ns)[5] transverse traveling wave pump with the three dye solutions Rh6G, RhB, and Cumarin C311 to obtain 45, 55, and 45 ps ultrashort dye ASE laser pulses, a compression ratio of better than 10 to 1.

In the experimental apparatus as shown in Figure 1, the N_2 laser (λ = 337.1 nm, pulse width 0.7 ns, and single pulse energy 270-400 μJ) from a vertical direction projects onto a reflection grating (2,400 lines/mm). At φ = 54° there is a diffraction and a delay is produced.[6] The diffracted beam passes through a cylindrical lens focusing at the dye pool, constituting a transverse traveling wave pump. When the diffraction angle φ and the dye solvent's index of refraction η satisfy the relation tan φ = η, the dye light radiation advances along the AB direction. Each time it reaches a point nearly in step with the peak value of the pumping pulse, the AB direction gets a unidirectional amplified laser beam. The forward light compared to the backward light is clearly intensified, producing a dye ASE light pulse. Using an 0.7 ns pulse width N_2 laser pumping Rh6G gave 300-400 ps pulse width ASE. Their wave form is shown in Figure 2. The reason that this sort of wave form is produced is related, we believe, to the arrangement of the optics. Because the excitation zone of the transverse pump and dye pool is pencil
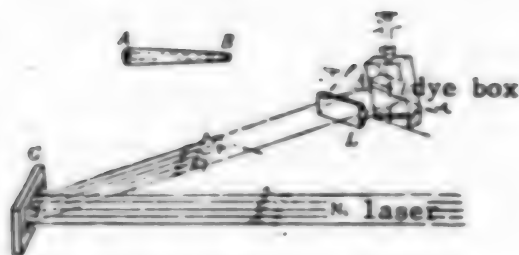
Figure 1.   Experimental Apparatus

G = 2,400 lines/mm;
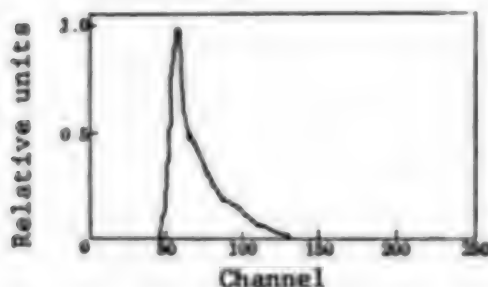L = Cylindrical lens, f = 60 mm

Figure 2.   Strip Camera Image of the Traveling
Wave Amplified ASE Light Pulse

shaped, each point in the zone has equal excitation power density. Under
conditions of traveling wave pumping, the light pulse produced by stimula-
tion first at the A end, amplifies along the AB direction forward following
a changing slope but quickly saturates and the pulse peak value cannot
increase more but the radiation of the pump's later stimulation comes on its
heels forming a longer tail.

In order to get even shorter light pulses, we made advances on two points:
1) Changing the power density spatial distribution of the excitation zone
in the dye medium; and 2) appropriately selecting the dye concentration.
We moved the sample pool making the point A be slightly off the focus while
B continued to fall at the focus. This way the excitation zone formed a
circular cone (Figure 1). Along the direction AB there was produced an
excitation power density gradient. The gain G_0 of the dye medium increases
from A to B. Reasonably choosing the included angle of AB and the cylindri-
cal lens focus line can give the best light intensity ratio between the
forward and backward light. At the same time we also observe that the ASE
light pulse in the process of traveling wave amplification gets compressed
(Figure 3). In the figure: (a) the traveling wave amplification excitation
zone ℓ = 20 mm, pulse width is 65 ps; (b) ℓ = 14 mm, pulse width 108 ps;
and (c) ℓ = 7 mm, pulse width 194 ps. The experiment was done using an Rh6G
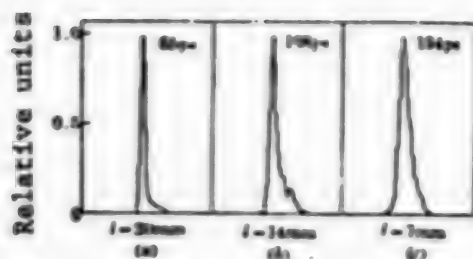$C = 2.8 \times 10^{-2}$ mol/l solution.

Figure 3.   Effect of Traveling Wave Amplification
Distance on Pulse Width

Changing the Rh6G concentration from 7.5×10^{-3} mol/1 to 2.8×10^{-2} mol/1, the pulse width is further compressed with increasing concentration. Moreover, in the center of the forward beam there is a clear bright spot. Figure 4 shows the influence of dye concentration on the pulse width. Concerning this phenomena we propose a preliminary explanation: In a dye laser system with a cavity, usually the dye concentration is 1×10^{-3} mol/1 and the light radiation must go back and forth several times inside the cavity (for example 5 to 10 times) before it obtains sufficient gain to output a light pulse. Now we have increased the concentration over 10 times so in the same optical path it can get the gain of 10 times back and forth in a low concentration cavity thus producing the laser phenomena. The concentration increase is beneficial to the compression of the pulse because of collisions and other factors that will greatly shorten the fluorescence lifetime of the dye molecules.
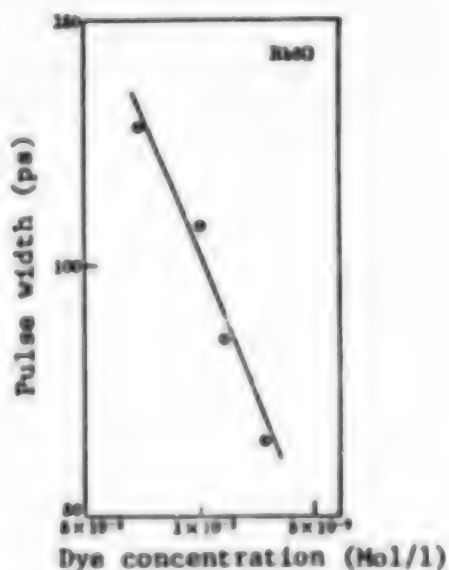

Figure 4.   Influence of Dye Concentration on Pulse Width

The results we obtained in experiments using Rh6G, RhB, and Cumarin C311 dyes are contained in Table 1.

Table 1.

Dye	Rh6G	RhB	C311
Concentration (mol/l)	2.8×10^{-2}	2.5×10^{-3}	5×10^{-3}
Pumping energy (μJ)	434	434	434
Output pulse	-		
Pulse width (ps)	45	55	45
Energy (μJ)	5.13	13.7	20.5
Conversion efficiency (percent)	1.2	3.2	4.7
Bandwidth (nm)	6.8	10.7	5.7
Central wavelength (nm)	600	591	458

In addition to this we also used a grating spectroscope (focus = 2 m, disper-sive power 0.45 nm/mm) to photograph the dye ASE spectrum of the three dyes' traveling wave pumps. The results are included in Table 1. For C311 dye under general pumping energy this is a continuous spectrum but after the pumping energy is increased, a clear spectral structure emerges (Figure 5). We are just now doing research on this phenomena.

Figure 5. Traveling Wave Amplified ASE Spectrum
of C311 Under High Excitation Power

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FIRST NATIONAL SYMPOSIUM ON FREE-ELECTRON LASERS

[Article by Ji Zhong [4764 6988]]

[Text] The first Chinese national scholarly conference on free-electron lasers was held in Lanzhou City from 4 to 8 August 1986. This conference was proposed by the Nobel Prize winning physicist, Yang Zhenning and received the active support of the State Education Commission. Lanzhou University undertook the responsibility for arranging the conference. Twenty-two scientists from 14 work units in various parts of the country, including Hong Kong, participated in the conference. The editorial department of the CHINESE JOURNAL OF LASERS was also invited to send a member.

The scientists exchanged their own research results of the past few years, evaluated the present theories of free-electron lasers, and proposed topics for the direction of future research. They also made constructive proposals on how China can further expand research work in this area.

The participating scientists happily noted the progress China had achieved in theoretical and experimental aspects of free-electron lasers and were confident that the development of free-electron lasers would make the proper contributions.

In order to promote the timely exchange of individual research results and to enliven scholarly thought in this area, the participating scientists decided to hold regular free-electron laser report sessions and conferences. The next conference, to be held in Chengdu, is set for 1987.

The free-electron laser is a new model laser which came out of the developments of the latter part of the 1970's. The outstanding advantage of free-electron lasers is that they are capable of outputting very high power and their energy conversion efficiency is very high. Also, the wavelength of the laser can be adjusted continuously within a wide range. Of special interest is that it is at present the most practical means to obtain X-ray laser radiation. Consequently, free-electron lasers have great application value in defense, industry, and scientific research. Other countries stress R&D of this type of laser a great deal, expending large quantities of labor and material.

12966/9365
CSO: 4008/0027

LASER-EVAPORATED PULSED ATOMIC BEAMS

[Article by Zhang Yanping [1728 1693 1627], Hu Qiquan [5170 0120 6898], Shu Haizhen [5289 3189 3791], and Lin Fucheng [2651 4395 2052] of the Chinese Academy of Science, Shanghai Institute of Optics and Fine Mechanics; paper received 13 September 1985; first paragraph is source-supplied English abstract]

[Text] Abstract: This paper systematically studies laser experimentally evaporated atomic vapor from the viewpoint of atomic beams. Using a sort of pulsed atomic beam we carried out experiments with multiple photon photo-ionization of refractory metal atoms and discussed photo-ionization signal detection.

1. Introduction

In nonlinear laser spectral regions, people have used multiple beam lasers to do selective excitation and photo-ionization with respect to atoms, bringing about spectral study of high excitation states of atoms (especially Rydberg states and free electron states). Application of the results of these studies has provided atomic methods to separate isotopes and to detect trace elements in matter. For these studies and their application, an atomic beam apparatus is required. Traditionally heating methods have been used (for example, ohmic heating, electron gun bombardment, etc.) to hieve an atomic beam source.

The material and technological demands of these sorts of heating methods for an atomic beam apparatus are high making the equipment complex as well as expensive to build. If the sample is a radioactive element, there are also protection difficulties. For these reasons, on the laboratory scale, we designed a small scale laser evaporation pulsed atomic beam apparatus. Its use inside the laboratory can open up spectral study of the high excitation states of refractory metals. Further, it can expand into a laser mass spectrometer. This paper introduces our experimental research on laser evaporation pulsed atomic beams as well as application of this beam to carry out nonresonant multiple photon, photo-ionization experiments on refractory metal atoms.
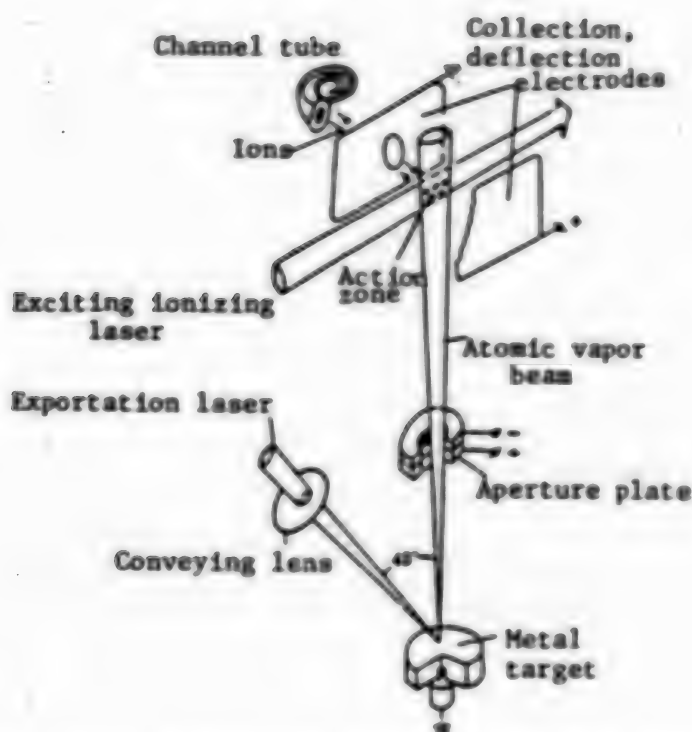
2. Pulsed Atomic Beam

Figure 1. Laser Evaporation Pulsed Atomic Beam Apparatus

The entire apparatus is composed of a glass sealed system. Figure 1 is a diagram of the principle components. The evaporation laser incident ray forms a 45° angle with the target plane, this is for the convenience of apparatus design and to reduce the contamination by the evaporating material of the incident ray aperture as well as the mutual effects of the laser and the light lobes. The 1.06 μm laser pulse output by the modulated Q YAG laser oscillator serves as the evaporation light which, passing through a lens is focused on the target plane, producing a neutral atomic vapor. The power density at the focus spot is $10^8 - 10^9 W/cm^2$. The action zone is about 200 mm from the target and has on either side two, flat electrodes made of pure copper 0.5 mm thick that serve as deflector and collector for charge carrying particles. In one electrode there is a small hole. This electrode has a fixed deflection potential to make the signal electrons produced in the action zone go through the small hole and enter the channel tube and be amplified. The channeling tube is placed in the vertical along the diffusion direction. This is in order to avoid receiving the head-on bombardment of charge carrying particles in the vapor. The amplified signal is sent to a detection system outside of the apparatus to be recorded.

The experiment adopted the method of laser evaporation sedimentation to measure the angular distribution of the vapor. The degree of vacuum of the evaporation chamber was 5×10^{-3} Torr and the sample target was brass.

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Above the target vertically at 11 mm there hung an optical glass plate for sedimentation of the metal vapor. After the laser pulse evaporated 100 times, the glass plate was already clearly plated with a coat of brass film. By measurement of the transmissivity distribution we got the distribution of relative film thickness from which was obtained the angular distribution of diffused vapor (sample results are given in Figure 2 where the broken lines are extrapolated). Based on the angular distribution, we found the average half intensity angle $\overline{\theta}_{1_2}$ = 37.12°. A comparison with the angular distribution obtained with the ordinary heating method for atomic vapor after passing through slit collimation of thickness l and width d revealed[1] that the vapor diffusion angular distribution of laser evaporation equalled the angular distribution of an ordinary atomic beam after passing through a slit where $l/d = 0.5 \sim 1$. This demonstrates that in diffusion, the vapor from laser evaporation itself possesses a certain directionality. Consequently, it can be made into a sort of particle beam. According to Knudsen's Cosine Law[2]

$$dm = \frac{m}{\pi} \cdot \cos\theta \cdot d\omega \tag{1}$$

in which m is the evaporated mass in unit time, θ is the acute angle formed between the solid angle $d\omega$ and the line normal to the target plane. This way, the angular distribution of the deposited film thickness on the glass plate parallel to the target plane is

$$s(\theta) \propto \cos^4\theta \tag{2}$$

Compared to experimentally measured results, as can be seen in Table 1 in which each value is the average result in four different directions, we see that when angle θ is small, experimental results and formula (2) match very well. When θ is larger, the experimental values diverge slightly. This is because the evaporation at a fixed point forms an indentation making the vapor plating distribution figure contract.[3] This explains why the laser evaporation at the target forms a transient vapor surface source. According to quantity of evaporation, the lower limit of the atomic vapor density at the action area is computed to be $5 \times 10^9 \text{cm}^{-3}$.
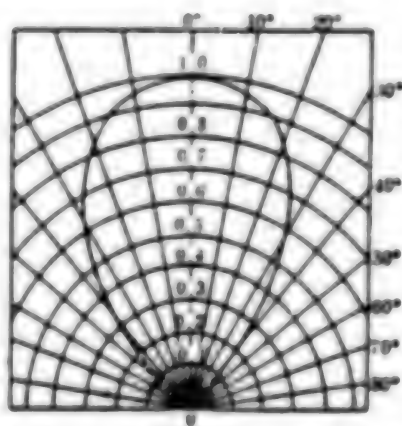

Figure 2. Diffusion Angle Distribution of Laser Evaporated Vapor

Table 1. Average Measured Thickness of Brass Film Deposited (Normalized)

θ	0°	10°	20°	30°	40°
Average thickness	1	0.97	0.88	0.68	0.43
$\cos^2\theta$	1	0.97	0.88	0.75	0.58

Using the measurements of electrical signals in the experiment and considering the effects of displaced current, we got the transition time of charge carrying particles from the target to the action area and calculated the flight velocity of these particles to be 3×10^6 cm/s. This is basically the same as the ion velocities obtained by reference 4 using flight times. It is also fundamentally identical to the light lobe frontal diffusion velocities given in reference 4. This shows that the velocity of the charge carrying particles is rather fast and the centralized distribution is at the front of the vapor pulse.

In order to obtain more features of pulsed atomic beams, the experiments studied the temporally and spatially resolved emission spectra of the evaporation light lobes. The degree of vacuum of the evaporation chamber was kept above 10^{-5} Torr and the target was brass. The evaporation light lobes, using a lens with focal distance, f = 140 mm formed an image on the input slit of a half meter optical grating monochromator. The lens was fixed on graduated translational sliders which could be precisely adjusted to change the position of the light lobe image with an accuracy of 0.1 mm. Figure 3 gives sample temporal and spatial resolution emission spectra. From Figure 3 we see that wave form (a) has a clear double peak structure of which the first comes from the continuous background emission of the light wings and the second pulse comes from the emission of a CuI521.8 nm spectral line.
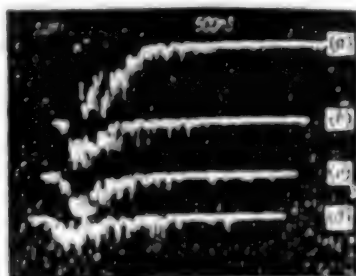

Figure 3. Spatial Changes of Light Lobe 521.8 nm Emission Wave Form in a Vacuum

Distance from the target: (a) 0; (b); 0.5 mm; (c) 1.0 mm; (d) 1.5 mm

As the light lobes diffuse outward, the continuous background quickly vanishes and usually remains in a 1.0 mm range near the target plane. The area enclosed by the second pulse wave form is represented by the spectral line

intensity of the light lobes at a certain point in space (the integral with respect to time). It is monotonically decreasing meaning that in a vacuum, pulsed atomic beam neutral particles, in diffusing do not produce the excitation process of nonelastic bombardment. Consequently, we believe that the first continuous background peak arises from heat emission of the glowing light lobes and, as the second pulse wave form diffuses, the trailing edge gradually stretches. This is caused by the velocity distribution in the vapor's neutral particles. From the rise time lengthening of the pulse wave form we calculated the most probable speed of the excited state particles to be about 2×10^5cm/s. This is identical to the most probable speed of ground state neutral atoms computed by reference 5 using laser induced fluorescence methods to get temporal features of the density distribution of neutral free electrons. It is evident that in the pulse atomic beam the velocity of the majority of neutral free electrons is less than the velocity of charge carrying particles. Because of the existence of the cascade and radiation capture processes, from the temporally resolved emission spectra in Figure 3 we can see that the existence time of excited state particles in the light lobes is lengthened. Further, when the evaporation chamber is filled with any type damping gas (e.g., He, Ne, or Ar) of fixed pressure, experiments revealed that luminous clouds were produced at the outer range of the light lobes. Study of the spatial changes of the excited spectral wave forms of the camping gas atoms showed that when the laser shines on the target, before the atomic vapor is produced, a thermal reflection produces a quick electron pulse. These quick electrons bombard and excite the damping gas atoms forming the luminous clouds outside the light lobes. In the emission spectra of the damping gas atoms, the spectral lines of the corresponding higher excitation potential are: NeI585.2 nm (excitation potential 18.96 eV), HeI587.6 nm (excitation potential 23.07 eV). If we believe that the higher energy level particles of these spectral lines all pass through corresponding metastable state (NeIS_5, $1S_3$, He2^1S_0, 2^3S_1) cascade excitation, and the excitation potential of NeIS_5, $1S_2$, and He2^1S_0, 2^3S_1 meta-stable states is about 17 eV, then these fast electrons ought at least to have energies of 17 eV.

The above experimental study shows that when the laser shines on the metal target, first there is a higher energy quick electron pulse which is produced from the thermal emission. Afterwards the laser evaporation produces a surface source provided pulsed atomic beam. Since the velocity of charge carrying particles in the beam is larger, the bulk of them are concentrated in the front part of the pulse atomic beam. The speed of the majority of neutral free atoms is slower so their density distribution is definitely not the same as the charge carrying particles (see below). Reference 7, based on experimental measurement of electron emission pulse wave forms produced by laser single pulses believes that before the evaporation beam there is a quick electron pulse produced. Moreover, using deceleration potential methods they measured the quick electrons to have energies of 14.5 eV. Obviously, the conclusion reached by the two methods is largely the same.

Because at the same time as laser evaporation produces a pulsed atomic beam, the adjoining part charge carriers are produced, if we want to utilize pulse atomic beams to study the multiple photon, photo-ionization of atoms, the existence of charge carrying particles must interfere with detection of

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photo-ionization signals. Wanting to suppress completely the charge carrying particles in the vapor, we only have to reduce appropriately the power density of the evaporation laser. This means to suppress the charge carrying particle situation we must reduce the density of the atomic vapor.

3. Application of the Pulsed Atomic Beam: Multiphoton Photo-Ionization of Refractory Metal Atoms

The evaporation laser used a 1.06 μm laser pulse output by a modulated Q YAG laser oscillator, a focal distance f = 110 mm lens to focus on the refractory metal (Cu, Al), target plane, and focus spot power density of $10^9 W/cm^2$. We let the pulse atomic beam travel in a 10^{-5} Torr vacuum. Used in the photo-ionization was an 0.53 μm laser pulse, pulse width 15 ns produced by a separate Q YAG laser oscillator after double amplification and passing through a KDP crystal doubler, the evaporation light with which it corresponded had a modulation delay (range 200 ns - 16 μs). The delayed 0.53 μm laser was vertically incident on the atom beam path and by a focal distance f = 100 mm lens was concentrated on the action zone with power density at the focus point of $3 \times 10^8 W/cm^2$. Using the collecting plane electrode directly to collect photo-electrons produced by photo-ionization this time we only applied a small deflection direct current potential (-1.2 V) or none at all. The signals collected were displayed directly on a wideband oscilloscope. Figure 4 gives a sample observing conditions of multiple photon photo-ionization signals.
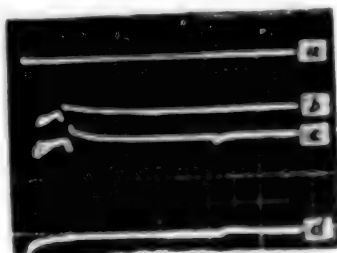

Figure 4. Nonresonant Multiple Photon Photo-Ionization Signals

(a) 0.53 μm; (b) 1.06 μm; (c) 1.06 μm, 0.53 μm; (d) delay monitor (1.06 μm and 0.53 μm represent the incident laser wave length). The scale of (a), (b), and (c) is 10 mV/div, (d) is 20 mV/div

The (d) trace signal in the figure is produced by the diffused light of the 1.06 μm and 0.53 μm lasers received by a photo diode and is used to monitor the delay between the 1.06 μm and 0.53 μm lasers. The (b) trace signal appearing just after the evaporation laser is caused by quick electron pulses. Space charge carrying effects make the signal change in a complex way. The (c) trace signal is the signal obtained after the pulse atomic beam produced by the 1.06 μm laser shines on 0.53 μm laser. The small peak in step with the 0.53 μm laser is the   multiphoton photo-ionization signal we want to observe. The (a) trace signal is the single incident 0.53 μm laser when there is no atomic vapor. That there is no signal illustrates that the multiphoton photo-ionization of the background gas (10^{-5} Torr inert gas) under experimental conditions can be ignored.

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The photo-ionization signal observed is part of the nonresonant multiple photon photo-ionization signal because the minimum energy difference between atomic energy levels of either Cu or Al and the energy of multiple photons (the detuning quantity) is always far larger than the line width of the 0.53 μm laser.

Experiments changing the delay of the 0.53 μm laser discovered that the amplitude of the photo-ionization signal did not change throughout up to the maximum delay of 16 μs. Obviously then, the photo-ionization signal cannot come from single or double photo ions of highly excited state atoms of Cu or Al because the above study has shown that even if a cascade process is present and there is radiation capture, the time interval during which the high excitation state exists cannot exceed 1 μs (see Figure 3). There is also the question of whether or not the photo-ionization signal with respect to Cu comes from triple photon photo-ionization of meta-stable $(3d^9 4s^2 \, ^2D_{5/2,3/2})$ atoms. For this reason, experimentally we divided the 0.53 μm laser into two beams, one of which was used to pump dye obtaining a laser with wavelength of 578.2 nm, power 10^4W, and line width 0.02 nm. Its wavelength was standardized by the pulse photoelectric effect of a hollow cathode Ne-Cu lamp. After combining the 578.2 nm laser and the other 0.53 μm laser beam and shining on the Cu atomic beam there was no resulting signal increase. This shows that the Cu photo-ionization signal was not primarily from triple photon photo-ionization of $Cu3d^9 4s^2 \, ^2D_{5/2,3/2}$ meta-stable state atoms. Also, the second ionization potentials of Cu and Al (Cu, 20.29 eV; Al, 18.82 eV) both far exceed their first ionization potentials and the possibility that the photo-ionization signal comes from a valence ground state ion is extremely small. From another point of view, because the (tuochugong) of Cu is 4.47 eV,[6] when a 0.53 μm laser illuminates the surface of the pure copper collecting electrode, multiple photon photo-ionization effects are easily produced. Could the signal observed above come from photo-ionization effects caused by the 0.53 μm laser at the collector plate electrode? To find out, in an experiment we intentionally aimed the 0.53 μm laser directly onto the collector surface and looked for multiple photon photo-ionization effects. The results showed that the signal amplitude produced by the photo-electric effect was far greater than the photo-ionization signal. The fundamental distinction between the two is that when there is no atomic vapor the photo-electric effects can be produced by the 0.53 μm laser alone but the photo-ionization signal is impossible; a point which is also proven by the absence of a signal trace in Figure 4(a). In summary, the multiple photon photo-ionization signal comes from the photo-ionization of ground state atoms of Cu or Al and the fact that the signal amplitude value does not change with changing delays shows that the existence interval of neutral free atoms is rather long (>16 μs). Moreover, due to the velocity distribution, their density distribution becomes spread out.

Because we were concerned with atomic vapor density and did not exercise any control over charge carrying particles in the vapor, they disturbed the detection of the photo-ionization signal rather much. In the experiments, when we changed the deflection potential of the collection plate electrode we discovered that when no deflection potential was applied, disturbance to the signal primarily come from thermally emitted quick electrons (see

Figure 4(b)). When the deflection potential was 1.2 V, because there is a microplasma in the vapor, the interference to the signal is clearly increased and stretched out in time. At this time the photo-ionization signal is repeatedly added on top of the envelope of the disturbed signal pulse. When the deflection potential is increased to 45 V, the disturbing signal is further increased and annihilates the photo-ionization signal. It is evident that the existence of charge carrying particles has a great influence on signal detection on the collector plate. Using a channel tube to detect the signal runs into the same kind of problems. Experimentally moving the focusing lens of the 0.53 μm laser to change the active zone revealed that when the active zone is near the collector plate the photo-ionization signal gets larger and when the action zone approaches the two collector plate electrodes, the polarity of the two corresponding photo-ionization signal pulses reverses (see Figure 5). This tallies with the explanation of signal detection above. At the same time, using excited light to trigger a pulse potential makes the collector potential increase on the collector plate electrodes. This way the disturbing signal is reduced and the collection of photo-electrons is increased.

Figure 5. Sign Change of Photo-Ionization Signal Pulse When Action Zone Approaches Two Collector Plates

(With 1.2 V DC collector potential)

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CORNEA DAMAGE THRESHOLD FOR XeCl EXCIMER LASERS

[Article by Xu Jiemin [1776 4309 2404], Zhou Shuying [0719 3219 5391], Cao Weiqun [2580 4850 5028], Shi Liangshun [2457 5328 7311], and Qian Huanwen [6929 3562 2429] of the Second Institute of the Academy of Military Medicine and Science, and Fu Shufen [0265 3219 5358], Chen Jianwen [7115 1696 2429], and Qi Zhangfen [2058 1728 5358] of Chinese Academy of Sciences, Shanghai Optics and Fine Mechanics Institute; paper received 9 September 1985; first paragraph is source-supplied English abstract]

[Text] Abstract: Ocular dose response was experimentally determined by exposing chinchilla rabbit eyes to XeCl excimer laser light at 308 nm. The corneal damage threshold ED_{50} (effective dose for 0.5 probability of producing a biomicroscopically visible corneal lesion) was found to be 0.83 J/cm (95 percent C.L. was 0.749 - 0.911 J/cm^2).

The location and degree of ocular damage from ultraviolet lasers varies with the wavelength and irradiation time. Consequently, in the present laser safety standards the irradiation limits for far ultraviolet and near ultraviolet lasers are different. But up to now there have been few reports on the biological effects of 308 nm wavelength nanosecond pulse far ultraviolet lasers. This paper gives the damage thresholds for XeCl ultraviolet excimer lasers with respect to corneas, for reference in working out relevant safety standards.

Experimental Instruments and Method

The experimental irradiation apparatus is seen in Figure 1. The laser radiation wavelengths used were 307.9 and 308 nm, pulse width 8 - 10 ns, output laser spot dimensions were 5 x 10 mm^2, and the diffusion angle of the laser beam was 10 mrad. In front of the output end of the laser a ϕ5 mm diaphragm was placed. A lens was used to form a reduced image of the diaphragm at the incident plane of the cornea. The diameter of the laser spot was 1 mm.

For laser dose measurement we used the method of split-beam monitoring. To measure the dose at the irradiation site we employed a JNK-1 laser energy meter while the monitoring position used an NJ-J1 laser energy meter. Getting the split-beam ratio from the monitored dose, we converted to get the energy
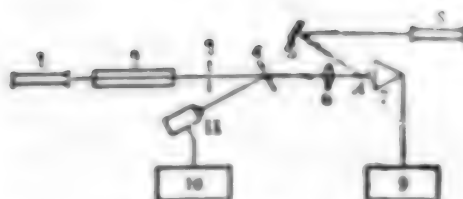
Figure 1. Irradiation Path

1, 8: He-Ne lasers; 2: XeCl excimer laser; 3: diaphragm;
4: Beam splitter; 5: Mirror; 6: Lens; 7: JNK-1 model laser
energy meter; 9, 10: Direct current complex galvanometer;
11: NJ-J1 model laser energy meter; A: Cornea irradiation
plane

density incident on the cornea. The measuring instruments were standardized
by the Chinese Measurement Science Research Academy.

For experimental animals we used chinchilla rabbits with body weight of
about 2 kg. Before irradiation, those with normal corneas were selected
using slit lamp examination. During irradiation, the intersection point of
the two He-Ne laser beams indicates the position of the corneas irradiated.
Each cornea was irradiated at 5 spots. Ten minutes to 1 hour after irradia-
tion, slit lamp examinations were done and with 1 percent luciferin dye were
checked by two or more people. Twenty-four to 48 hours after irradiation
there were followup inspections. A portion of the eyeballs were removed and
pathology and histology observations made.

Experimental Results

The experiment irradiated a total of 62 rabbit eyes or 363 sample points.
The irradiation dose ranged, incident to the cornea plane, from 0.474 to
1.78 J/cm^2.

1. Manifestation of eye damage: Within the irradiation dose range used,
cornea damage was dominant and there was also slight damage to the camera
oculi anterior and the iris. Cornea damage manifested as round light gray
or gray-white cloudiness with clear edges. The damaged surface revealed
fine, circuitous gray-white wrinkles, the focus of which did not stand out.
The luciferin dyed portion changed color. All the damage manifestations
were slight and surface, limited to the upper layer of the cornea. Twenty-
four hours after irradiation, part of the focus had retreated and part had
remained as light gray spots. At 48 hours the damage had largely retreated.

Immediately after irradiation the pupils were contracted and the irises
slightly congested. Ten to 20 minutes after irradiation, the camera oculi
anterior displayed slight flocculation mostly in the perimeter of the pupil.
Twenty-four hours after irradiation, the pupils were restored to normal size
and the floccule was basically absorbed. In groups where the irradiation

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dose was higher, several days after irradiation, the membrane between the eye-lid and eyeball was slightly congested and there were slightly white colored secretions.

2. Relationship between irradiation dose levels and frequency of cornea damage: The experiment irradiated a total of five dose groups. The results show that the frequency of cornea damage increased with dose level (Table 1). With a dose of 1.78 J/cm^2 incident to the cornea plane the frequency of cornea damage stood at 92.7 percent. For a dose level of 0.474 J/cm^2 the damage frequency was 12 percent.

3. Computation of the cornea damage threshold value (ED_{50}). The laser cornea damage threshold value normally indicates the necessary dose for the probability of evident damage to the cornea to be 50 percent upon inspection with a slit lamp. Statistical processing was done on the results of the experiment using Bliss probability unit weight iterative regression to get the regression equation of the XeCl excimer laser irradiation dose log (X) and the cornea damage probability unit ($\hat{Y}$) and ED_{50} as follows. The regression line is shown in Figure 2.

$$\hat{Y} = 5.358 + 4.420 \ X$$
$$ED_{50} = 0.83 \ J/cm^2$$

(95 percent confidence limit $0.749 - 0.911 \ J/cm^2$)
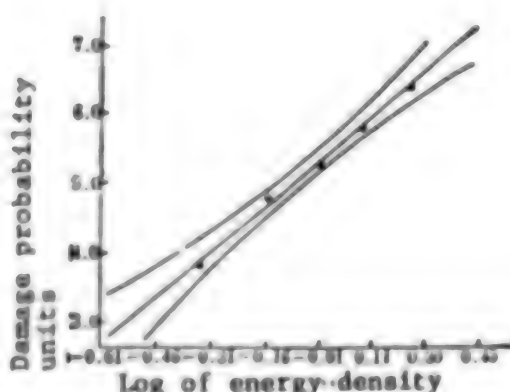
Figure 2.   Relationship Between Probability Units of Damage to
Rabbit Corneas Irradiated by XeCl Excimer Laser and
the Log of the Dose

Using the X^2 value to check, the experimental group $X^2 = 0.5493$, was far lower than the $X_{0.05}$ boundary (7.815). This shows that the linear relation-ship between cornea damage probability units and the log of the dose is good. That is, the theoretical model if experimental results and the ordinary dis-tribution of the dose log for laser eye damage effects match up. From the regression equation the ratio of ED_{60}:ED_{50} or ED_{50}:ED_{20} is 1.55.

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Table 1. XeCl Excimer Laser Irradiation Dose and Occurrence Rate of Rabbit Cornea Damage

Experimental group	Cornea irradiation dose average (J/cm^2)	Cornea damage frequency	
		Damage number Irradiated points	Percent
1	1.78	51/55	92.7
2	1.32	40/50	80.0
3	0.996	32/50	64.0
4	0.710	21/50	42.0
5	0.474	6/50	12.0

INHIBITORY EFFECT, DNA DAMAGE OF HYDROXYCAMPTOTHECIN ON KB CELLS

[Article by Wang Xinwei [3769 1800 0251], Shen Zuming [3088 4371 6900], Yang Jinlong [2799 6855 7893], and Xu Bin [5171 1755] of the Shanghai Institute of Materia Medica, Chinese Academy of Sciences; paper received 3 September 1985; first paragraph is source-supplied English abstract]

[Text] Abstract: Hydroxycamptothecin (HCPT) is an antitumor alkaloid isolated from Camptotheca acuminata Decaisne, a tree native to China. The present investigation showed that HCPT possesses strong cytotoxicity on KB cells using the colony formation method. The ED_{50} was found to be 0.2 μg/ml after 1 hour exposure to the drug. HCPT exhibited a significant damaging effect on DNA of KB cells. Its cytotoxicity was shown to be associated with its direct action on DNA strands. It could induce formation of cellular chromatid breaks and increase the frequency of SCE. The effect of HCPT on SCE was found to parallel the inhibition of colony formation. It was demonstrated that HCPT could induce protein-associated DNA single-strand breaks by means of alkaline elution method. The K_m values of DNA elution kinetics of KB cells were found to be 0.04, 0.10, 0.12, and 0.14 H-1 in the control group and in the treated group with HCPT 10, 50, and 100 μg/ml, respectively.

Hydroxycamptothecin (hereafter HCPT) is a kind of antitumor active alkaloid.[1] It has signficant and damaging effects on tumor cells. Results from clinical applications[2] show that it is promising antitumor medicine. HCPT can inhibit the activity of α-polymerase,[3] and inhibit the synthesis of the DNA of tumorous cells.[4] It can also improve the activity of the adenyl cyclase of the cell membrane,and change the proportion of the cyclic nucleotide system of the cell.[5] However, it is not known how HCPT interferes with nucleic acid metabolism, and the mechanism that leads to the death of cells. This complicated problem requires further research. This article is a report on the use of the plate colony formation method to study the effects of HCPT on tumor cells in colony formation, chromatid breakage, sister chromatid exchange (SCE), and DNA single-strand breaks. This will further clarify the direct effects of the mechanism of HCPT on cell genetic material.

Materials and Method

1. Reagents

HCPT is prepared by our institute. A little 0.5N NaOH is added to HCPT. The solution is then diluted with saline. It is then filtered, sterilized, and kept at low temperatures. [^{14}C] TdR (53 Ci/mM) is supplied by the Radioactive Medicine Institute of the Academy of Medical Sciences. 5-bromo-deoxyuridine (BUdR) and sodium dodecylsarkosine (Sarkosyl) are products of Sigma Co. in the United States. Tetraethylammonium hydroxide (Et$_4$NOH) is a product of the First Reagent Manufactory of Shanghai. Proteinase-K (20 manson units/mg) is a product of Elmford Co. in the United States. Polyvinyl chloride filter (type BS-2) is a product of Millipore Co. in the United States.

2. Cell Culture

KB cells were supplied by the Beijing Medical Institute. The cells are diluted to a concentration of 5 x 10^5/ml and inoculated into plastic culture flasks (Corning, 25 cm^2). The contents of the flasks include 10 percent fetal calf serum, 100 IU/ml penicillin, 10 ml of Eagle's MEM complete culture solution containing 100 µg/ml streptomycin. The inoculated solution is kept at a growth environment of 37°C, 5 percent CO_2, and saturated humidity. The cultures are harvested every 3-4 days.

3. Plate Colony Formation Method

Use 0.05 percent trypsin-0.02 percent EDTA digestive reagent to form single-cell suspension from synchronized cells obtained from cultures that were incubated for 24 hours using the technique of mitotic detachment. Four hundred of these cells are inculated into plastic culture containers (Falcon) diameter at 60 mm. When the cells are plated, determine under the microscope that the plated cells are indeed single cells. Then add reagents for the appropriate amount of time, use Hank's solution to elute the reagents. Then add complete culture solution to continue culturing for 8 to 10 days. Add methanol and glacial acetic acid to fix the plated colonies, and stain with Giemsa stain. Obtain count under the dissecting microscope. A colony is defined as a group with more than 50 cells. Comparing the treated group with the control group, obtain the survival fraction (SF). For each concentration the figures represent the average value of at least three samples.

4. Chromatid Breakage Method With Slight Improvements on Methodology in Literature [6]

Seed 25 cm^2 culture flasks with cell suspension at 1 x 10^5 /ml concentration. After 48 hours of incubation, 1 hour of reaction with reagents, and 4 hours of reaction with 0.04 µg/ml ammonium colchicine the cells are trypsinized and collected. The cells are observed under oil immersion (1,000 x) after being treated with 1 percent sodium citrate, fixed with methanol and glacial acetic acid, prepared on slides using the "flaming technique," and stained with 10 percent Giemsa. The standards of chromatid breaks is reported according to literature [7]. For each sample 50 complete cells in their metaphase are examined. SCE methodology and observations are conducted according to literature [8].

5. DNA Single-Strand Breakage Tests

Refer to Kohn's alkaline elution method.[9] The major steps are: cells are marked for 48 hours by [^{14}C]TdR of 0.05 µCi/ml concentration. Then treat with reagents. Use ice-cold solution to stop reaction. Use EDTA-PBS (-) to wash cells and use a small rubber spatula to collect the cells. Suspend the cells in PBS (-) buffer solution, and keep ice-cold for later applications. Place cells in funnels containing polyvinyl chloride, and add 0.2 percent Sarkosyl, 2M NaCl, 0.04M NaCl-EDTA (pH 10.0) under reduced light conditions to dissolve the cells. Allow the reaction to continue for 1 hour. If necessary, add solution (pH 9.7) containing 0.5 percent mg/ml protein enzyme K, 2 percent SDS, 25 mM NaCl-EDTA to react for 1 hour. Connect the funnel to a peristaltic pump, carefully add Et$_4$NOH elution solution (pH 12.1) containing 20 mM EDTA (acid form). Elute at 0.04 ml/min pumping speed. Add 70 µl acetic acid, and mix with a specified amount of scintillation fluid (containing 0.4 percent PPO, 0.03 percent POPOP and toluene and Triton X-100) to form a rubberlike fluid. The proportion of water, toluene, and Triton X-100 is 4:3.6:2.4. Use a YSJ-7R model automatic fluid scintillometer to determine the dpm value of the fluid.

Table 1. Effect of HCPT on Chromatid Breakage in KB Cells

Dose (µg/ml)	Number of metaphase cells				P
	0	1~4 (breaks/cell) 5~9		>10	
0	41	8	1	0	—
0.1	48	2	0	0	>0.05
1.0	35	12	3	0	>0.05
10.0	0	38	39	3	<0.001

*Cells were pulse treated with HCPT for 1 hour, following 4 hours incubation with colcimid;

**50 well-differentiated metaphase cells were counted in each treatment.

Table 2. Incidence of Sister Chromatid Exchanges (SCE) in KB Cells Treated With Hydroxycamptothecin

Dose (µg/ml)	$\bar{X} \pm SD$	P
0	0.085 ± 0.044	
0.1	0.240 ± 0.092	<0.001
1	0.811 ± 0.304	<0.001

*30 well-differentiated metaphase cells were studied in each treatment.

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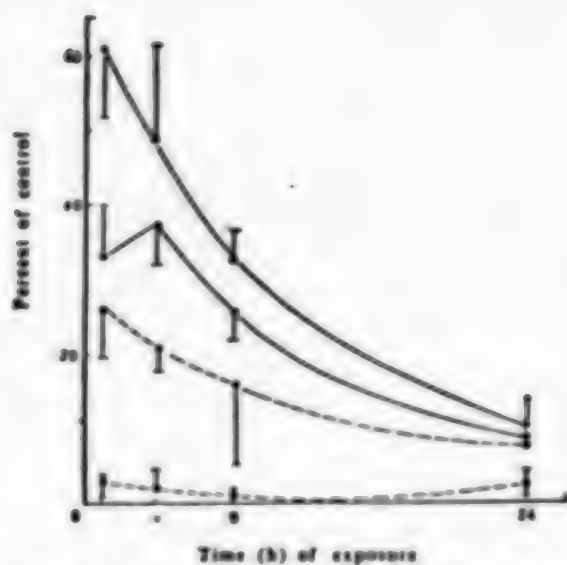
Figure 1. Survival of KB Cells After Continuous Treatment With HCPT Determined by Colony Formation Method

o——o 0.1 µg/ml; •——• 0.5 µg/ml;
o----o 1.0 µg/ml; •----• 5.0 µg/ml
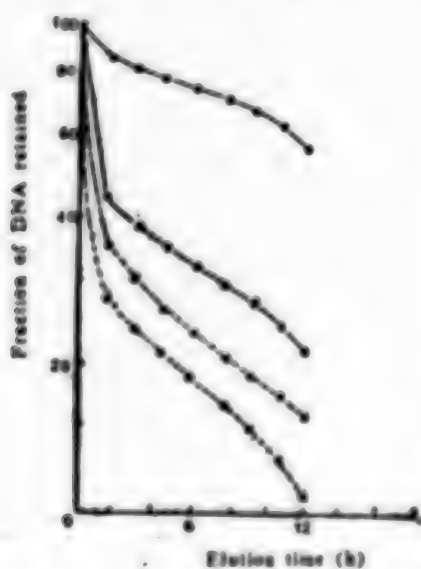
Figure 2. Elution Kinetics of DNA From KB Cells Prelabeled With [^{14}C] Thymidine and Treated With Proteinase K Incubated With Various Concentrations of HCPT for 1 Hour

o——o 0 µg/ml; •——• 10 µg/ml; o----o 50 µg/ml; •----• 100 µg/ml

Figure 3. Relationship Between the Elution Rate and HCPT Dose

Results

1. The results on colony formation of KB cells

As shown in Figure 1, CPT can significantly control colony formation of KB cells. After reacting with HCPT at 0.1, 0.5, 1, and 5 µg/ml concentrations, the SF value is respectively 60.9 ±9.7 percent, 32.3 ±7.8 percent, 25.5 ±6 percent, and 2.3 ±1.3 percent. The ED_{50} value was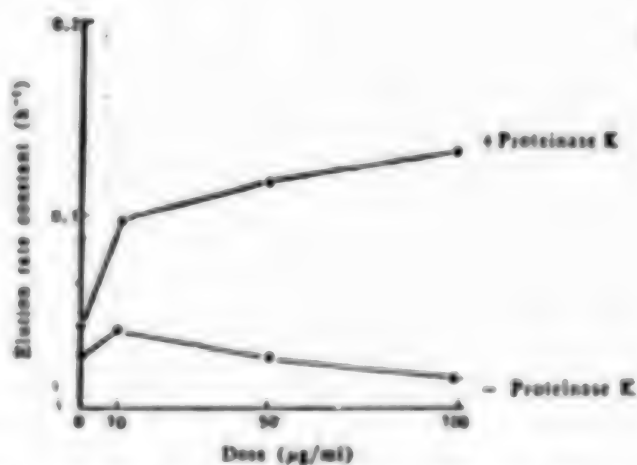 0.2 µg/ml. Extending reaction times significantly lowers the SF values. At 24 hours the SF values all drop to less than 20 percent. At 5 µg/ml concentration there were basically no colony formations. These results show that HCPT has fairly strong controlling effects on cells cultured in vitro. It manifests inter-dependence correlations between dosage and effect as well as time and effect. Significant effects can be produced in a short time.

2. The effects on single-strand breakage of KB cells

In the experiments, 0.1, 1, and 10 µg/ml reagents were used. HCPT was demon-strated to cause cell single-strand gaps and single-strand breakage. The breakage position is usually at the longer segments of the chromatid. Table 1 shows the results of the number of breaks. When 0.1 and 1 µg/ml of reagents were used, the proportion of cells with no single-strand breakage was at 48/50 to 35/50, basically equal to the results of the control group which was 41/50. With 10 µg/ml, the proportion of cells with no single-strand breakage dropped significantly to 8/50. Cells with observed single-strand breakage significantly increased, the proportion of cells with 5 or more breakages rose to 12/50.

3. The effects on SCE of KB cells

HCPT can cause single-strand breakage. In order to determine whether this damage still exists after chromosome repair, we observed SCE effects after 1 hour of reaction with the reagents. The results are shown in Table 2. In the group with 0.1 µg/ml, the exchange rate was about two times that of the control group (P < 0.001). With 1 µg/ml, the exchange rate was nine times that of the control group, a very significant difference (P < 0.001). The effects are consistent with the correlation between dosage and effect. When the amount increased to 10 µg/ml, the exchange rate was impossible to determine. The above results show that the chromosome damage by HCPT exists even after chromosome repair.

4. The effects on DNA single-strand breakage

The 5, 10, and 20 µg/ml of HCPT reagent were allowed to react with KB cells for 1 hour. The effects of the reagent on the change of the elution kinetics of DNA strands were observed. This experiment was performed to determine whether the reagent has direct harmful effects on the structure of the DNA strand. Results show that the above amount of HCPT can increase the rate of elution of DNA single strands, but the effects are not significant. The 20 µg/ml group eluted to 12 hours, the DNA that remained on the filters was still at 34 percent. The reagent group when compared to the untreated control

group increased its elution rate by 100 percent. When the amount was increased to 50 and 100 μg/mℓ, the elution rate of DNA was hindered significantly. When 0.5 mg/mℓ proteinase-K was used to treat the cells, the elution rate increased significantly (Figure 2). When the amount of DNA remaining on the filters was at 55 percent for the control group, the 10 μg/mℓ group was already at 21 percent, the 50 μg/mℓ group was at 16 percent, and the 100 μg/mℓ group was at 11 percent. The coefficient of elution kinetics (Km) at 0, 10, 50, and 100 μg/mℓ is 0.04, 0.10, 0.12, and 0.14 h, respectively (Figure 3). The value of Km of the 100 μg/mℓ group increased almost three times against that of the untreated control group.

Discussion

The reasons that reagents may control cell growth are as follows: 1) direct elimination of cells; 2) structural change of cell membrane; 3) disruption of the structure and function of nuclic acids and/or proteins. Antitumor drugs that have direct effects on DNA molecules by altering their structure usually have significant effects on chromosomes. Cells in their metaphase will show alterations.[10] This article began by investigating the effect HCPT has on chromosomes. The results showed that HCPT has fairly weak direct breakage effects on tumor cell chromosomes. In dosages capable of killing cells, HCPT only increased the rate of single-strand breakage slightly. This shows that this breakage effect is probably not the main mechanism of cell death with this drug.

Many researchers[11,12] claim that the formation of SCE and the duplication of DNA strands are related. From the results of this study, 0.1 μg/mℓ HCPT can cause significant SCE effects, and the effect is increased by twice that of the control group. The survival proportion of cells in this case is 60.9 percent. At 1 μg/mℓ, the SCE rate increased to about nine times, cell survival proportion dropped to 25.5 percent, indicating that the occurrence of SCE parallels that of the toxicity to cells. This further indicates that HCPT may damage DNA strands, affect the duplication of strands, and cause cell death. This effect may also be related to the inhibition of repair of DNA strands. Furthermore, we have studied the effect of HCPT on the fibroblasts in Chinese hamster fetuses,[13] and showed that 1 μg/mℓ HCPT increased SCE by only two times, and increased dosage did not cause SCE to significantly increase. When compared with the above results, we conjecture that HCPT may have higher selection bias towards cancerous cells as opposed to normal cells.

In alkaline elution tests, DNA is treated with proteinase-K. The observed result is a significant increase in the elution rate. Proteinase-K can remove all the protein in cells, including the group protein and the nongroup protein which are attached to the DNA strand. The results obtained indicate that HCPT can cause damage to DNA strands, the nature of which has obvious relation to the effect of protein on DNA breakage. Small dosages cause simple single-strand DNA breakage. Massive dosages cause DNA single-strand breakage that is related to the effect of protein. This phenomenon is different from that of other kinds of anticancer drugs such as chloronitrous-ethylurea, nitrogen mustard, cis-platinic ammonium chloride which cause damage in the DNA of cancerous cells. Whether this reaction is related to the

activation/repair enzyme system, which causes proteinases to attach to the breakage points of the DNA strands is a topic that requires further research.

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CURRENT SITUATION, OUTLOOK OF INSTRUMENT, METER MATERIALS

[Article by Fan Wentong [2868 2429 6639], senior engineer of Chongqing Institute of Instrument Materials]

[Excerpt] I. Foreword

The nation's earliest instrument assembly industry emerged in Shanghai in 1914, starting to produce the first electric meter in 1929 with both the material and parts imported from overseas. After liberation, China has been diligently engaged in the development of the instrument industry with fair progress from the 1950's to 1966 and a corresponding growth in instrument material industry. The initial production of permanent magnetic steel in Dalian Instrument Plant in 1949 can be regarded as the infancy of China's modern instrument material industry. Thereafter, the Ministry of Metallurgy established 8 precision alloy bases producing special alloy materials of over 200 types and 3,000 plus specifications, as well as engaging in the production of semiconductor materials. The Ministry of Electronics set up the industrial production system of magnetic materials and semiconductor materials, along with partial electronic ceramic specialization. There were 27 plants for magnetic materials alone. The Ministry of Machinery established the domains in magnetic steel casting, temperature sensing materials, electric resistance materials, and optical glass, respectively, having 14 material specialty plants, over 6,000 staff with production worth close to 200 million yuan. In addition, the Chongqing Institute of Instrument Materials, specializing in the study of instrument materials, was established in 1961. Despite the interruption during the Cultural Revolution, after 10 years of reorganization and development, our instrument materials industry has basically formed for China an independent system promoting and ensuring the development of instrumentation.

The instrumentation industry is experiencing a revolution of its own with the current industry's development toward electronics and information, with the electronic technology, micro-photoelectric technology and the application of microcomputers being the core of this instrumentation technology revolution. The change from a dispersed and backward status to keep abreast with this trend is an urgent task. The following are some personal assessments

regarding the current situation and the outlook of instrument industry development. Criticism and correction are welcome.

II. Current Situation

The so-called "instrument materials" have been developed in response to the developmental needs in instruments and meters. It is no exact definition nor a stringent domain, serving primarily thermal engineering and electrical engineering instruments in the early days. For instance, the "measuring materials" which started to emerge in Japan in the 1950's are the "instrument materials" we are referring to. However, electronic technology with rapid and overwhelming development in the 1960's has progressively penetrated the instrument industry. Electronic materials serving the electronic industry has developed interweavingly with "measuring materials," and demanded attention. In general, the Western countries refer to them directly as magnetic materials, semiconductor materials, elastic alloys, and so on. This has probably been dictated by the diversification of instrument materials and the lack of concentrated study and manufacturing. The Ministry of Machine Building Industry has identified the definition and the categories of instrument materials with Specification JB3750-84.

1. Definition: Instrument materials are "in the manufacturing of instrument meters, as well as in the installation of those materials in functional units and operating mechanisms which capture, convert, transport, display or store such parameters as electricity, magnetism, light, heat and force."

2. Categories: 17 categories in total, with 840 major products at the present time, where 1) temperature sensing materials--78; 2) electric resistance materials--77; 3) permanent magnetic materials--49; 4) soft magnetic materials--16; 5) elastic materials--47; 6) sealing and expanding materials--4; 7) thermal materials--15; 8) electric vacuum materials--14; 9) electric contact materials--44; 10) precious metal materials and products--27; 11) instrument structural materials--19; 12) soldering adhesive materials--13; 13) semiconductor materials--10; 14) optical materials--359; 15) special glass--36; 16) ceramic material--6; 17) other instrument materials--26.

This classification of instrument materials is not exactly scientific. However, it facilitates to illustrate the development stages of instrument and meter materials, their current situation as well as the critical evolution moment they are in. The current situation of the several major materials are as follows:

1. Temperature Sensing Materials

Temperature is an important parameter in industrial processes. Various temperature measuring subjects using thermocouples have been studied in depth since the discovery of the Seebeck Effect in 1886. According to statistics, there are 270 kinds of materials which have been studied as of the present time, over 50 kinds of which being in use, with a temperature measuring range from $\leq$ 4.2K to $\geq$ 2773K achieving a usual precision of

±0.4 percent to ±10 percent; 7 of them have been listed in the IEC Standard. In addition, four kinds from China, the Soviet Union and the United States are listed as the national standards.

Ever since its invention by the Dutch Philips Company in 1957, the armored thermocouple has experienced rapid development in these 30 years because of its small size, flexibility, high mechanical strength, fast response, and excellent adaptability to the environment. Our country has prepared four specifications in 1978.

Internationally a thermocouple called Nicrosil-Nisil is being studied. It can reduce drastically the instability of high temperature thermoelectricity, enhancing anti-oxidation capabilities. When used in a nuclear field, because this material contains no such nuclear field transmuted element as Mr, Co or Cu, in 1985, the Office of the Secretary of IEC65B published draft 97 which made possible main stream in mid-temperature thermoelectric measur ﹣ ment. In high temperature measurement, material consistency and bending tenacity have been enhanced, unifying the indexing values as a result of the improved processing technology for tungsten-rhenium thermocouple. In addition, a great number of fast thin-film temperature sensing thermocouples have been developed. In general, as a result of the studies of material subjects concerning the high temperature chemical compatibility with insulators, physical matching, catalytic temperature error, compensating line, and extreme low temperature measurement, the problems in the making and the use of thermocouples have been significantly resolved.

Resistance temperature sensing materials have developed tremendously in an attempt to enhance measurement precision. Platinum resistors are the largest volume in use. Our country produces about 500,000 a year, valued at over 10 million yuan. In 1985, China established five standard specifications of temperature sensing platinum filaments which met IEC751-83 specification. Their precision and stability meet the international standards of the early eighties. In addition, our country has been actively involved in the development of thin-film and thick-film platinum resistors and related coatings.

In addition to metallic materials, our country has achieved much in the development and manufacture of temperature sensing thermistors made of rare-earth and transition metal composite oxides, or transition metal composite oxides, as well as temperature sensing devices of silica diodes or silicon carbide diodes.

2. Magnetic Materials

Being an instrument material with extremely broad application, the magnetic materials are unparalleled in terms of production volume, variety, and depth of research. In 1984, the world production of permanent magnetic ferro-oxides alone was about 300,000 tons, and 100,000 to 150,000 tons output in soft magnetic ferro-oxides, along with metallic permanent magnetic materials, metallic soft magnetic materials, and rare-earth magnetic materials, the worldwide output reached 500,000 tons valued at over $3 billion. Our country

has also experienced rapid growth in recent years. In 1985, our country produced about 15,000 tons of permanent magnetic ferro-oxides, 2,500 tons of metallic permanent magnetic materials, for a total production of over 30,000 tons for all magnetic materials. Based on material types, magnetic materials can be classified into metallic magnetic material, semiconductor magnetic material, ceramic-type magnetic material, and macromolecular magnetic material, etc. The varieties are quite complex. According to the rough estimate, there are over 300 varieties in all, 70 to 80 varieties are soft magnetic materials, 30 to 40 are free-forming permanent magnetic materials, 20 to 30 are rare-earth permanent magnetic materials, and several dozen are soft magnetic ferro-oxides, and so on.

From the view of materials science and materials engineering, the study of magnetic materials is the most intensive and thorough. The theoretical study of magnetic materials has gone as far as the inside of atoms. From atomic magnetic distance, the calculation of Bohr magnetic numbers, and from the basic constant and coefficient of the material, the material's coercion, magnetic inductivity, magnetic hysteresis loop and the maximum magnetic capacity can be derived. Under the direction of theories of magnetism the limits of existing materials can be derived. The theories can also direct the search objective as well as the discovery of new materials. As a matter of fact, rare-earth permanent magnetic material and Fe-Cr-Co are invented under the guidance of coercion theory. The basic parameters of soft magnetic materials can also use the theories as guidance to adjust the composition and processing technology to achieve high performance materials as expected.

Because instrument materials are very sensitive to temperature, in most cases, Al-Ni-Co magnetic steel with a small temperature coefficient is used except for damped magnetic steel. However, with improvements in compensation technology and the reduced cost of rare-earth magnetic steel, the applications of ferro-oxides and rare-earth magnetic steel are expanding continuously, a sure trend in technological development.

3. Resistance Materials

Ever since the production of "Manganung" (manganese-copper alloy) by German Esabellin Metallurgy Company in 1889, due to its minimal resistance temperature coefficient ($\pm$ 1 ppm), high resistance stability (annual change rate no larger than 1 ppm), and low thermoelectromotive force with respect to copper (Ecu $\pm$ μV/°C), precision Mn-Cu is still used in almost all major precision instruments today. Nevertheless, it has drawbacks such as low ρ value (ρ = 0.43Ωmm^2/m), narrow rating temperature range (5-60°C), and difficulty in processing control. Consequently, nickel-chromium base alloy with higher ρ value, copper nickel base alloy with small temperature coefficient and ease in processing, have been developed. Because copper-nickel base alloy has too high thermoelectromotive force with respect to copper, it can only be used in alternating current series resistors. As for nickel-chromium base which has a higher ρ value but too large α value, it is not suitable in the use in precision resistors. It has been modified as "KAMA", and "YIWEN" alloys which are used extensively in precision resistors.

Nickel-based alloys have been drawing interest from researchers of various countries because of its high ρ value and smaller α. However, as of today, practicality has not yet been realized due to their poor processing characteristics and difficulty in control.

The greatest strength of precious metal resistance alloys is chemical stability and corrosion resistance. Thus, they are still used as high precision potentiometers in the defense industry despite their high costs.

In the case of precision resistance materials, in addition to the search for materials with even higher resistivity, the technology for existing material varieties is being improved constantly as well, in an effort to make smaller and thinner filaments and strips. Today, tiny filaments with a diameter of 0.01 mm can be pulled, and 2μ strip material can be rolled, which are reliable in quality and consistent in material. Nevertheless, as of domestically today, there is still a problem in steady volume supply.

In China, strain resistance materials did not become an independent area separated from precision resistance materials until the late 1960's. Strain constantan, Fe-Cr-Au strain alloy, Pt-W, Ni-Cr-Mn-Si and KAMA, YIWEN alloys have been developed. Both efforts have been made and objectives have been achieved in material consistency and, evenness in filaments and foils.

Our country began the research and development of metallic "PTC" material in the 1970's, primarily in iron based or iron-nickel base alloys. However, production capability has not yet been realized, and there is a lack in generalized application as well.

4. Elastic Materials

Elastic materials are used as diaphragms or elastic components, and floating filament, expander, spring, etc., in electric meters. The varieties are basically complete, primarily several dozen comprising copper base, nickel base, nickel-chromium base, cobalt base and iron base.

Following the rapid and vigorous development of the petroleum and chemical engineering industries in our country, and as a result of the increasing demand for automatic and various corrosion resistant instruments, a number of anticorrosion instrument elastic materials have been developed which have been widely used in such industrial production and scientific research as acid manufacturing, alkali manufacturing, agriculture chemicals, chemical fertilizer, natural gas, vinylon, papermaking, ocean development, and so on. Economic benefits have been realized. For example, when $40Ni_{16}Cr_3Ti_5Mo_3Cu$ alloy is used instead of 50CrV and $60Si_2Mn$ steel in the high sulphur fume field instrument, the life of the instrument was extended several dozen times. However, there are a number of problems in our nation's production of elastic materials. There is quite a lag in processing fineness and flushness compared with other foreign countries. In addition, because of the small quantity in instrument materials, most of the larger corporations are reluctant to manufacture; on the other hand, the medium and small corporations have difficulty meeting the above requirements. Special factories or research

institutes must be assigned and be given certain capitals along with strength-
ened technical capability so that specialized production of elastic alloys
used in instruments and meters can be feasible.

5. Sealing Materials and Leader Framing Materials

Initially, sealing materials are developed following the development of
electric vacuum technology. The standard sealing materials are quite mature,
comprising primarily nickel based and cobalt based alloys.

The leader framing materials have been rapidly developed with the advance
and progress in large-scale integrated circuit. Although a sealing material
by itself, however, with the increasingly high density and small size in
integrated circuit, the leader framing material is faced with a series of new
requirements. 1) High σ_b, σ_y, E values in mechanical property, a rigidity
with a matching tenacity; 2) good corrosion resistance, good surface electro-
plating and tin soldering properties; 3) good shape processability, and with
no residual stress as to ensure precision and quality in a processed unit;
4) good press soldering property; 5) excellent heat tolerance in high
temperature; 6) nonmagnetic; 7) low cost. As a result, an array of copper-
based alloys and composite materials have been developed over the world.
Our country currently has basically been using Ni-42 alloy, and actively
developing copper-based alloys as well.

6. Contact Materials

Contact materials in instruments and meters are primarily used in low current
situations such as various connectors, microswitches, integrated circuits and
brushes. These uses are characterized by low contact pressure (in the magni-
tude of grams), low power (with current in the magnitude of mA or μA). It
requires good electrical conductivity and chemical stability from the mate-
rials in order to assure the prolonged contacting reliability of the contact
points. Gold, silver, platinum, and palladium are generally the contact
materials used, with gold being an especially ideal material. However,
because of the high price of gold, other foreign countries employ such
methods as electroplating, selective plating, composite and substitute
materials in an effort to reduce gold consumption. Our country has been
engaged in some efforts in the area of gold base alloys, and is actively
developing such areas as gold plated layer and composite contact materials.
Nevertheless, there is still a big gap compared with other countries, and
diligence is needed in order to catch up.

7. Transducer Functional Ceramic Materials

Functional ceramics occupy an important position among functional materials.
In addition to high electric insulation property, altering the heat resistance
and chemical stability properties, through adjustment in chemical components,
introduction of trace elements, control of the microstructure and crystal
lattice, etc., the electric thermal and mechanical properties can be modi-
fied to make materials which are either thermosensitive, photosensitive,
magnetosensitive, moisture sensitive or gas sensitive. Although our country

has been engaging in the developmental work of functional ceramics since the 1950's, but emphasis is given and subsequently significant development is experienced only in the last 10 years. For instance, certain accomplishments have been achieved in such areas as NTC thermal resistor in the transistional metallic oxide system, PTC thermal resistor in $BaTiO_3$ system, Fe_3O_4, $MgCr_2O_4$-TiO_2, $ZnO-Li_2O-V_2O_5$ moisture sensitive resistors, SnO_2, ZnO, ZrO_2 gas sensitive resistors. Nevertheless, as of today, there exist the following problems: 1) insufficient stability; 2) poor reproducibility; 3) further enhancement in selectability is needed; 4) imperfection in interface and with accessory instrument. Consequently, the majority of functional ceramic materials are still in the stages of research, testing and promotion.

8. Other Instrument Materials

Semiconductor materials, optical materials (including optical fiber), and special glass are important instrument materials as well. Special discussions are already in place and thus will not be repeated in this article. The use of macromolecule materials as functional material of instrument electronics has a broad prospect, but domestically they are used in precision refining and in photo-etching gelatin used in the press. There are various levels in research, production and application in areas of photo-polymer, liquid crystal, static protection and shield in displays and connectors, electricity conducting plastics and rubber, coatings, cohesives, optical fiber and ion exchange resin used in communications and transducers, electricity emitting and piezoelectric materials, sound-electricity trans-ducers, oscillating materials, plastic magnetic steel, magnetic rubber, photomagnetic materials, and so on. Of course, the range of application of functional polymers is much broader, involving energy, chemical engineering, medical, food processing, bionics, etc., but in general, our country is still at the initial stage. The materials currently in use have a series of drawbacks such as erratic performance, fast aging and short life cycle which are pending future development and upgrade.

III. The Outlook

The modern new technological revolution is gradually expanding worldwide from highly industrialized countries, causing changes in a nation's society, politics, economy, culture and thinking. Lately, according to the estimate by a famous American economist Peter Drucker, the major changes in this development flow are: 1) Primary products have been disjointed with industrial products. The primary products in many countries have become peripheral and are no longer the core departments. 2) The demand for raw materials in industrial products has declined relatively. The annual decline is 1.25 percent since 1900. That is, the raw material in each and every industrial product is only two-fifths compared with 1900. 3) As a result of the emergence of high technology, the cost of raw material in a semiconductor micro chip is only 1-3 percent of the cost. The information transported in a 10-100 pound optical fiber cable is equivalent to that in a 1-ton copper cable. The cost of plastic including material and energy is only half that of steel. This illustrates that the time when the main stream is machinery manufacturing using large quantities of raw materials has progressively

transformed into an era whose center is high technology competition. The
transition from an industrial society to an information society causes
decentralization in enterprises. The core is the result of extensive
development in information technology centered around computers, photoelectron
technology, new energy technology, new materials technology, and so on. Our
country's industrial foundation is relatively weak, and there is still quite
a distance to modern technology, but the imminent arrival of an information
society is a sure trend. In order to promote the development into an informa-
tion society, the two areas in information technology have to be tackled,
namely, the collection and processing of information. Collection includes
sensing, conversion, transmission, and storage while processing includes
computing, identifying, display, extracting, and control as well. Therefore,
it includes electronics, and the full extent in instrumentation and communica-
tions. The emergence of this brand-new industry requires many types of
special functional materials. In terms of instrumentation, it must be
differentiated from the field which serves the regular electrical engineering
and thermoengineering instruments, so that it can serve the all new instru-
ments under the banner of artificial intelligence and computers, as well as
serving various information transducers. Thus, the materials themselves have
to struggle to be free from the old stereotype whose main body is primarily
metallic materials, and jump into the broad domain of metal, nonmetal, semi-
conductor, and polymer. Then, from the view of materials science and engi-
neering, a series of issues in crossing, overlapping and penetration are
presented. In addition, some of the fundamental theories and fundamental
techniques have become increasingly difficult to categorize. As a result,
there emerged a school dividing the materials into two main categories--
"structural materials" and "functional materials." Personally, I think this
kind of categorization suits the current situation rather well. Although a
good number of the functional materials have been developed on the basis of
structural materials, for example, functional macromolecular material is indeed
developed from engineering macromolecular material, many metallic elastic
materials are also developed on the basis of the original structural materials.
However, with the progress in materials science and the development in material
engineering, there have been increasingly more and more artificially synthesized
materials. Furthermore, there have been many new materials and new effects as
a result of modification and enhancement on the existing original materials.
Consequently, the research methods about them, and their service clientele
are different from the mass-production structural materials. Therefore, in
my opinion, it is scientifically logical to combine instrument materials,
electronic materials, and certain auxiliary materials having special require-
ments and necessary in the assembly of instruments and electronics, and to
address them as "functional materials." Using this as a basis, it is cer-
tain that tremendous progress will be made on the existing foundation, pro-
vided that there is comprehensive planning and coordination, as well as
cooperation.

1. Instrument and Electronic Metallic Materials

Judging from the development trend, because electronics and instruments
develop toward the unibody of mechanical-electronic instrument, coupled with
the uprising and practical use of semiconductor, ceramics, and macromolecular

materials, relatively speaking, in terms of the demand for metallic functional
materials, the growth rate will slow down while the absolute rate will still
increase. This is a result of relative weak foundation in our country which
in 2000, could only achieve the international standard of the late 1980's.
Our survey on the nationalized manufacturing for the 73 introduced items in
instrument system shows that, among the 255 materials requiring domestic
solution, there are 114 metallic materials constituting 46 percent which are
still the main stock but there will be substantial changes in variety and
specification.

1) Elastic Materials

As a result of the development in electronic engineering, the application of
elastic materials is no longer limited to instrumental elastic components,
expanders, or floating filaments. On the contrary, there has been a rapid
increase in consumption for plugs, electric switches, electric relays,
potentiometers and so on. In addition, the demand in volume for the leader
and framing materials used in integrated circuits is also rising rapidly.
The cost in material decreases in proportion as a result of miniaturization
of electronic components. There has been an increase in consumption of high
performance beryllium bronze. Because of the toxic nature of beryllium,
the research and development in substitute material for beryllium bronze
have accelerated. The application range for copper nickel-base alloy of
(sipinuodaer) electrolysis will expand. As a result of further integration
level in integrated circuit, there will be higher requirement of heat conduc-
tion and strength on the framing materials. Thus, the search for an elastic
material whose heat conduction and electric conductivity is around 80 percent
of that of copper remains a topic of the future. Similarly, high precision
and consistency in material sizes are also the pursued objectives.

Both chemical engineering, ocean development, and the mining of various non-
ferrous mineral ores, as well as nuclear industry and other industries, all
require elastic materials that are corrosion resistant to various gases and
solutions. In the days to come, material development, material processing
techniques and the setting of more logical method to determine anticorrosion
performance, as well as the spreading of application knowledge, the cold and
heat processing properties of materials, and the consistency in material
quality are research topics which would last for a period of time in the
future.

2) Contact Materials

As a result of miniaturization in instruments, gold-based contacts are
superior in contact reliability as well as stability. Nevertheless,
because of its increasingly large consumption and rising price, the
approach using composite contacts is gaining popularity and prevailing.
That is, 1) gold-plating on elastic materials, 2) gold-plating on other
inexpensive contact materials. Nevertheless, the gold consumption is still
rising continuously. In 1981, the industrial gold consumption in the world
was about 85 tons. Gold consumption in the electronics industry in the
United States and Japan alone represents 74.41 percent of the world's total

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industrial gold consumption. Consequently, the following measures are taken:
1) Improve plating solutions and electroplating technology to reduce the thick-
ness of the plating. 2) Employ local, selective electroplating techniques to
minimize gold-plated areas. 3) Use composite materials such as wrapper, etc.
4) Use substitution alloys in the connector/interface areas when the power is
large. Gold-palladium and silver-palladium will be the most promising sub-
stitutes. Our country is relatively behind in this aspect. However, due to
the urgent demands of the electronic and instrument industries, breakthrough
developments are required before the year of 2000.

3) Resistance Materials

Variety in precision resistance materials is already relatively set, but
high-stability precision-resistance materials with resistivity larger than 2
are still a research objective.

As a result of miniaturization and integration of resistance components,
the demand for ultra thin materials (thickness 3-5μ, and even 1μ super thin
strip) is on the rise.

There will be a certain increase in the consumption of metallic electric
resistance coating material and powder. Today in our country, diaphragm
resistors with a precision of ±0.1 percent and a resistance of 1-10 MΩ
have been successfully manufactured.

Metallic electric resistance materials having large temperature coefficients,
i.e., PTC, will enjoy expanded application.

4) Temperature Sensing Materials

In the area of direct temperature measuring, the thermocouple temperature
sensing materials are basically complete. The work to convert the indexing
scale in general thermocouples according to the international standards has
been completed. However, temperature measuring methods and materials for
various extreme conditions are still under exploration. Protective tubes
used in various hazardous environments and the sealing materials and
processing techniques for such protective tubes are under urgent study.
High temperature corrosion resistant environment, fusion compounds, liquid
metals, materials in various protective tubes used in nuclear industry
environments and the sealing structure for those tubes are still research
and development topics.

For the last several years, there has been a breakthrough in the research
and manufacturing of high temperature tungsten rhenium thermocouple. The
indexing as well as all the specifications have met the international IEC
standard. Our country has the advantage of vast resources rich in tungsten,
molybdenum, rhenium, etc., active development in this array of materials
should be promoted.

5) Metallic Magnetic Materials

As a whole, the relative consumption is gradually decreasing. In the casting of nickel-cobalt aluminum, due to the relatively large consumption of nickel-cobalt, wherever possible, ferro-oxides and rare-earth magnetic steels are used as substitutes. Nevertheless, because of its advantage of having a low magnetic temperature coefficient, its consumption in general instruments is still quite large. Although processable iron chromium cobalt can be processed and has the advantage of low cobalt consumption, but due to the relative complexity in processing techniques and the drop in the price of cobalt alloy internationally, the advantage has been partially offset, as a result, the consumption for the last several years has not increased. Nevertheless, the research in this area continues, and it is estimated that significant development is unlikely before the year 2000.

6) Others

There has been some progress in applications research of noncrystalline metal materials in instrument electronics. It is expected that the aspects in magnetism and solders would have applications sooner than other areas.

There has been a great deal of study in the application of shape memory alloys as energy material. The use of instruments as temperature control units has been in use in certain ranges and domains.

The application of super plastic alloys in special components used in instruments does d- rve consideration.

2. Ceramic Materials

1) Insulating and Dielectric Ceramics

The ceramics of early industrial application are insulating ceramics and dielectric ceramics which are gradually set in place. After the advent of the semiconductor industry, new requirements are posed for insulating ceramics. For instance, in the case of various high performance ceramic base tile and packaging materials, there are stringent requirements in terms of precision in size, surface polish and smoothness. However, there are yet quite a number of problems in domestic application. In addition, the heat radiation problem and vacuum switching problem associated with high power semiconductors where high parity, high thermoconductivity BeO ceramics and high strength Si_3N_4 are used are yet to be resolved. Similarly, dielectric ceramics is heading toward the development direction of high capacity and miniaturization.

2) Because of the uprising of transducer in great quantity, semiconductor ceramics is in a prime era. Domestically the emphasis in study pertaining to thermal resistor units is the expansion of the utilization spectrum, research in batch consistency, and development of high temperature characteristics with a hope that $1000°C$ temperature measuring can be realized before the year 2000. Our country has been manufacturing NTC's which are

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either used as temperature compensation with a stringent control on B or used in measuring temperature having a high B. Domestic products of CTR used in alarms and PTC used in temperature control while shielding from magnetism lack stability, and significant development within 10 years is expected.

The study in moisture sensitive resistors is beginning, however, the technology for steady batch production and complete facilities in specification verification will be the tasks in the years to come. Application in various aspects is expected to be realized in the 1990's.

There are few studies domestically on gas sensitive units despite their urgency. Some of the documents and reports so far are primarily the sintered SnO_2 and ZrO_2 system family. With the increasing enforcement on environmental pollution monitoring control as well as the demand on traffic and mine safety, it is expected that domestic production of gas sensitive components in the control of flammable gases, oxygen, and reductive gases can be realized within the coming years.

3) Ceramic Ferro-Oxides

With the perfection in processing techniques and the abundance and low cost for its raw material, the production of ceramic ferro-oxides is in the dominant position in the domain of permanent magnetic materials, and such a development momentum will not diminish through the year 2000. According to foreign estimates the worldwide production in ferro-oxides was 220,000 tons in 1980, reaching 300,000 tons in 1985, with a production of 350,000 tons is estimated for 1990, constituting over 95 percent of the worldwide production in permanent magnetic materials. Despite the discovery of neodymium-iron magnetic steel whose maximum magnetic capacity is above 50 MGOe and the potential rapid expansion in its application, but due to its high cost and the constraint in resource, it is expected that the applications will still be limited in certain particular areas and the leading position of ferro-oxides will not change.

3. Semiconductors

The diameter of a silicon single crystal has reached $\phi 75$ with domestic research and manufacturing in the last 30 years, coupled with the introduction of technology. Since the 1970's, the integration rate in integrated circuits has been doubling each year (from 256 bits in 1970 to 256K in 1984). It is expected that 10^8-10^9 single-chip ultra large-scale integrated circuit could be achieved by the year 2000. Thus, for the silicon single crystal whose diameter is to be developed from $\phi 150$ to $\phi 200$ (already successfully manufactured by Japan), and larger ones that have zero bit error, low carbon content and whose oxygen content can be controlled at will, it is expected that the leading position of the silicon single crystal will not change because of its maturity in processing technology. Therefore, the ability to rapidly keep abreast with this technological specification is a major objective for our nation.

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As a further enhancement in integrated circuit speed, a series of new devices and materials has been introduced, including the Josephson Device. From the standpoint of materials, the focus is primarily on GaAs. It is anticipated that the proportion of GaAs in Japan in the 1990's will reach 5-10 percent, and that the computing speed of fast computers in the year 2000 can reach 10^{11} calculations per second. Thus, the research for the GaAs single crystal with a diameter reaching $\phi 75 \pm 1$ mm and with a bit error density below $8 \times 10^3/cm^2$ is the major breakthrough objective for our nation before the year 2000.

4. Macromolecule Materials

At the present time, high performance macromolecule materials have enjoyed extensive application in semiconductor technology. In addition, the production in them is rising steadily because of their series of strengths such as being able to be synthesized, easy to process, and light in weight. Its application in optical systems is even more impressive. However, their particular and special properties have not yet been fully utilized. There have been domestic reportings on their applications in optical sensors, moisture sensors, infrared sensors, and so on. Because ceramic and semiconductor sensors are in the nascent stage in our country, it is conceived that there would be no increase in magnitude in macromolecular functional sensors by the year 2000. Nevertheless, some expect that there will be significant development in functional macromolecule materials in the future (the development trend in sensor materials in the following table can be used as a reference). It can be seen from the table that currently the macromolecule materials only constitute 8.4 percent with only some increase in the future, while metallic, inorganic materials and semiconductor constitute over 80 percent approximately. The outlook shows that polymers will share one-third, composite materials will share 20 percent, constituting more than half when the two are combined.

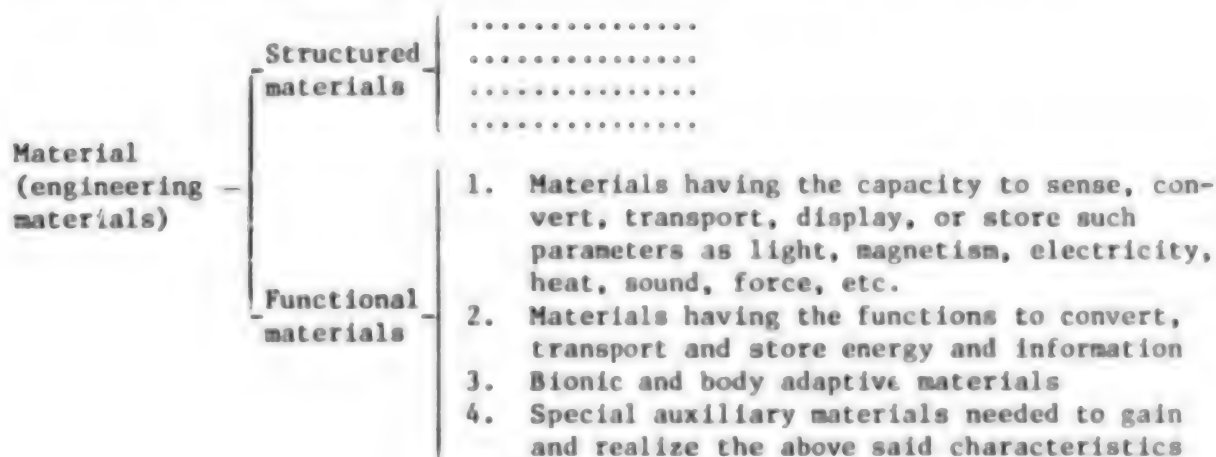Development Trend in Sensitive Materials Used in Sensors

Type of material	Percentage (%)		
	Present	Near future	Future
Metals and alloys	19.8	13.1	10.3
Inorganic semiconductor	43	49.7	20.3
Inorganic materials excluding semi-conductor	18.9	17.1	12.4
Polymers and enzyme	8.4	9.9	33.3
Composite materials	3.9	7	19.4
Others	6	3.2	4.3

IV. Some Opinions and Recommendations

At the present time, the development of instrument materials is at a critical turning point, and how to continue is an issue demanding our serious exploration. Several initial ideas are presented as follows.

1. Because there are a series of new requirements as a result of the use of electronics in instruments and meters, the regular and usual instrument materials tend to stabilize and have a relatively downward tendency with some of them even starting to decline, while there are urgent demands on various new "functional" materials. The arrival of this phase has been accelerated as a result of the introduction of production lines for new instruments and meters in the last few years. Therefore, there is a need to prepare the policies rapidly, to enhance and intensify planning, and to change the current situation where the research and production in materials lag the demands.

2. The term "functional materials" has been gradually recognized by the materials science community. However, there is yet a substantial difference between its definition and the content contained therein. There has been a difference in the separation based on objective needs or from the view of materials science itself, or from a different view based on the function and mechanical property of the material, consequently, its definition will not be exactly the same as the aspect and range included. In my opinion, it is more appropriate to classify materials (engineering materials) into two main categories based on practical use: 1) structural materials, 2) functional materials (please refer to the diagram), with all the engineering materials outside structural materials being classified as "functional materials." The benefit in doing so is: 1) There is clarity in the basic grouping as to facilitate segregation in engineering and operation. 2) The fundamental research methods and focuses for the two main types of materials are different, each can bring the individual characters and strengths into full play. From the view of physical properties, the primary pursuits in structural materials are mechanical property, strength, durability, life span, and the ability to satisfy the needs of the national economy's various areas by its high volume and quality as well as low cost. On the other hand, "functional materials'" special characteristics are judged on their ability to satisfy the requirements presented by modern new technologies and advanced technologies, while research and manufacturing costs will tremendously exceed the cost of the raw materials (the costs of some raw materials have become insufficient). The research in functional materials requires coordination from multiple branches of science, as well as armament in precision and advanced equipment and instruments. Thus, relatively speaking, the needed investment is constantly rising.

	Structured materials	. . . .
Material (engineering materials)	Functional materials	1. Materials having the capacity to sense, convert, transport, display, or store such parameters as light, magnetism, electricity, heat, sound, force, etc. 2. Materials having the functions to convert, transport and store energy and information 3. Bionic and body adaptive materials 4. Special auxiliary materials needed to gain and realize the above said characteristics

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3.   It can be seen from the above classification that the functional materials industry is knowledge intensive. Not only huge manpower and material investment are needed in the research and development, but substantial effort is also required in processing development and product manufacturing, so that it can gain actual application in the new technology, thus it can be regarded as a capital intensive industry. In order to bring the existing potential into fuller play, and to catch up with the world's advanced level, universities and technical schools, research institutions, related factories and corporations should be organized under the banner of "functional materials" regardless of system or field, to perform comprehensive planning, comprehensive coordination, divide the tasks but cooperate, and to bring the individual specialty and expertise into full play, so that a greater effect can be achieved. The instrument and meter materials is a branch of functional materials, and should bring its own function into full play under the general objective of functional materials.

4.   Specific Considerations and Recommendations

a.   Establish a specialization group using the name of "functional material" under "National Material Symposium." This group is to first perform investigation on the nation's current situation about functional materials, to perform analysis, and to set short-term and long-term planning and consideration as a reference for the government leadership.

b.   Establish a "Board of Functional Materials" under which there would be certain specialization committees to promote and mobilize the development of the work.

c.   Appoint a unit department for the preparation of publishing "functional materials" special issues to undertake the promotion and introduction to the outside world.

There could be many errors and imperfections due to the author's limitation. Criticism and corrections are welcome.

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PERMANENT MAGNETIC MATERIALS CURRENT SITUATION, PROSPECTS

[Article by Zhao Youmin [6392 0147 3046], Shanghai Magnetic Steel Plant, and Lin Qiren [2651 0366 1103], Shanghai University of Technology]

[Excerpts] Abstract: This article presents comments and discussions, of the current situation and prospects domestically as well as abroad, on permanent material's mechanism, function and application, material development characteristic, manufacturing technology, performance level, production volume and markets. Two points in remark to vigorously develop permanent magnetism industry are suggested.

I. Foreword

Hc is the center subject as far as permanent magnetic materials are concerned. A material's saturated magnetization intensity (Bs) and anisotropy constant (K) are critical parameters of a permanent magnetic material, while the magnetic transition temperature (Tc) is an indication of thermal stability of the material. High magnetic anisotropy will produce high Hc. The magnetic anisotropy can be the lattice anisotropy, as well as the shape anisotropy. The imperfection in lattice, and a new theory about the field wall having pinpoint defects also explain the noticeable increase in Hc. Table 1 shows the physical property, Hc mechanism and the theoretical $(BH)_{max}$ value for permanent magnetic materials.

There are many types of instrument materials. Table 2 shows the production volume of Japan's electronic materials. It can be seen from the analysis that magnetic materials are the largest consumer of electronic materials, with permanent magnetic materials constituting 50 percent of electronic materials, while permanent magnetic materials constitute 60 percent of all the magnetic materials. Japan's electronic industrial product in 1985 is estimated at 26 trillion Japanese yen, weighing 25-30 percent in the material gross product and with the product exceeding the steel industry. According to the recent statistical information by the Chinese Board of Electronic Magnetic Material Business (then being organized), the gross product of our country's magnetic materials is above 400 million yuan.

Table 1. Physical Characteristics of Permanent Magnet Materials, Hc Mechanism and Theoretical (BH)$_{max}$

(1) 固 体	饱和磁化强度 $4\pi M_s$ (kG)	各向异性常数 K ×10^7(erg cm^3)	居里点 Tc (℃)	(5) 结 构		(6) 矫顽力机理 (7) 晶体各向异性 (8) 形状各向异性 (9) 钉扎			(10) (BH)$_{max}$ (MGOe)
AlNiCo (AlNiCo₅)	14.6	2.6—3.0	890	a_1(11)体心立方 a_{10}=2.86Å a_2(11)体心立方 a_{20}=2.90Å γ(12)面心立方 a=3.65Å γ_1(12)面心立方 a=3.59Å a a=2.87Å			▲▲		35～30
铁氧体 (13)	4.78	Ba～ 0.33 Sr 0.37	450	M型 BaO·6Fe₂O₃ a=5.876Å c=23.17Å W型 BaMe₂F₁₆O₂₇ CoFe₂O₄		▲▲		▲	6 5.8
Fe-Cr-Co		1.6	670	a_1 a=2.884Å a_2 a=2.883Å γ σ			▲	▲?	18
Mn-Al-C	7.3	1	300	τ(14)四角晶 a=3.94Å a=3.58Å ε(15)六角晶系 a=2.69Å c=4.36Å			▲	▲?	12
PtCo		2.05	825	无序结构:(16) 面心立方(12) a=3.763Å 有序结构:(17) 面心四角(12) a=3.798Å c=3.694Å			▲		15
RCo5(SmCo₅)	10.7	16	724	六角晶系(12) a=5.004Å c=3.969Å					29.6
(CeCo₅)	7.7	6.2	347	六角晶系(15) a=4.922Å c=4.019Å		▲▲		▲	14.8
(PrCo₅)	12	10	612	六角晶系(15) a=5.013Å c=3.980Å					30
(MMCo₅)	≈8.0	≈8.0	≈620						19.8
R₂Co₁₇ Sm₂Co₁₇ Sm₂(Co₁₋ₓFeₓ)₁₇	12.0 16.3	H_A=100kOe	920 992	六角晶系(15)		▲▲		▲	40
Nd-Fe-B	16.1	4.4	312	四方晶 Fe₁₄Nd₂B(14) a=0.886Å 四方晶 Fe₄NdB(14) a=1.223Å a-Nd β-Nd }密排六角晶系(18)		▲▲			60

Note: This table was compiled from multiple sources, there could be differences in figures with individual documents; ? indicates disagreement, ▲ indicates mechanism's most important aspect.

[Key on following page]

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Key:
1. Magnet
2. Strength of saturation
3. Anisotropy constant
4. Curie constant
5. Structure
6. Coercive strength mechanism
7. Crystal anisotropy
8. Form anisotropy
9. Domain wall pinholes

10. Theoretical $(BH)_{max}$ (MGOe)
11. Body-centered cubic
12. Face-centered cubic
13. Iron oxides
14. Quadrangular structure
15. Hexagonal structure
16. Disordered structure
17. Ordered structure
18. Close-packed hexagonal structure

Table 2. 1982-1984 Japanese Production of Electronic Materials

Time	1982	1983	1984
Electronic materials (tons	99,811	125,875	159,482
Magnetic materials subtotal (tons)	79,495	98,962	122,321
Perm. mag. materials subtotal (tons)	51,476	61,668	73,111
Magnetic materials percentage of total	76.6	78.6	76.7
Perm. mag. percent of total	51.57	48.99	45.84
Perm. mag. percent of all mag. mat.	64.75	62.31	59.77

[Table 3 not reproduced]

Table 4. Permanent Magnet Manufacturing Methods and Processing

Method	Types of material suited to this method	Process work flow
Casting	AlNiCo, FeCrCo, FeAlC, MnCo, Sm_2Co_{17}	Burden / Molding → Smelting → Roughing (or crystal orientation) → Hot processing (or magnetic field orientation) → Machine processing → Inspection
Powder sintering	Iron oxides, R-Co, NdFeB, AlNiCo, FeCrCo	Burden (or mixing) → Smeltering and pre-sintering → Powder preparation (or mixing) → Pressure forming (or magnetic field orientation) → Sinter → Hot working (or induce a magnetic field) → Machining → Inspection
Rolling	FeCrCo, MnAlC, FeCoV, PtCo	Burden → Sinter initial form → Hot forge / Hot roll / Hot extrude → Form sheets Plates Wires Tubes → Heat treatment → Machine process → Inspection

Method	Types of material suited to this method	Process work flow
Quenching	NdFeB R-Co AlNiCo FeCrCo MnAlC	Burden → Smelt → Quench → Roll → Heat treat → Process → Inspect
Bonding	Bonded iron oxides Bonded R-Co Bonded NdFeB Bonded AlNiCo Bonded FeCrCo	Preparation of permanent magnetic powder → High temp treatment (to improve Hc) → Mix with bonding agent → Mold press → Low temp treatment (hardening or vulcanization) → Punching or shearing → Inspection

Note: Semi-hard permanent magnet materials are not included, so the rolling of semi-hard permanent magnet materials are not indicated.

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Table 5. Comparison of the Characteristics of Various Permanent Magnet
Materials

			Nd-Fe-B	R_2Co_{17}	Iron oxides	AlNiCo	FeCrCo
Magnetic charac- teristics	Residual magnetism T Br	(kG)	1.25 (12.5)	1.12 (11.2)	0.44 (4.4)	1.15 (11.5)	1.40 (14.0)
	Flux intensity kA/m Hcb	(kOe)	915.4 (11.5)	533.32 (6.7)	222.88 (2.8)	127.36 (1.6)	51.74 (0.65)
	Intrinsic coer- cive strength kA/m H_{cj}	(kO3)	1098.48 (13.8)	543.24 (6.9)	230.84 (2.9)	127.36 (1.6)	52.54 (0.66)
	$(BH)_{max}$	kJ/m^3 (MGOe)	286.56 (36)	246.76 (31)	36.62 (4.6)	87.56 (11)	47.76 (6)
	Reversible conduc- tivity μ_{rec}		1.05	1.03	1.1	1.3	2.6
	Temperature coeffi- cient (%/°C)		-0.126	-0.03	-0.18	-0.02	-0.03
Physical charac- teristics	Specific gravity (G/cm^3)		7.4	8.4	5.0	7.3	7.7
	Resistance ($\mu\Omega \cdot cm$)		144	85	$>10^4$	45	65
	Hardness (HV)		600	550	530	650	500
	Rigidity $MPa(kgf/mm^2)$		245 (25)	117.6 (12)	127.4 (13)	--	--
	Compressive resistance $MPa(kgf/mm^2)$		735 (75)	509.6 (52)	--	--	--
	Coefficient of expansion 10^{-6}/°C		3.4(∥) -4.8(⊥)	13	13(∥) 8(⊥)	11	12

V. Performance Comparison

Table 6. Magnetic Property of Ferro-oxide Permanent Magnets

Country	Model	Br T	(kG)	Hcb kA/m	(kOe)	(BH)max kJ/m³	(MGOe)
1)	Y10T	>0.2	(>2.0)	128~160	(1.6~2.0)	6.4~9.6	(0.8~1.2)
	Y15	0.28~0.38	(2.8~3.8)	128~192	(1.6~2.4)	14.3~17.5	(1.8~2.2)
	Y20	0.32~0.38	(3.2~3.8)	128~192	(1.6~2.4)	18.3~21.5	(2.3~2.7)
	Y25	0.35~0.39	(3.5~3.9)	152~208	(1.9~2.6)	22.3~25.5	(2.8~3.2)
China	Y30	0.38~0.42	(3.8~4.2)	160~216	(2.0~2.7)	26.3~28.5	(3.3~3.7)
	Y35	0.4~0.44	(4.0~4.4)	176~224	(2.2~2.8)	30.3~33.4	(3.8~4.2)
	Y15H	>0.31	(>3.1)	232~248	(2.9~3.1)	>17.5	(>2.2)
	Y20H	>0.34	(>3.4)	248~264	(3.1~3.3)	>21.5	(>2.7)
	Y25BH	0.36~0.39	(3.6~3.9)	176~216	(2.2~2.7)	22.0~27.1	(3.0~3.4)
1) SJ285-77	Y30BH	0.38~0.40	(3.8~4.0)	224~240	(2.8~3.0)	27.1~30.3	(3.4~3.8)

Table 7. Magnetic Property of AlNiCo Permanent Magnet

Coun-try	Model	Magnetic property					
		Br nT	(G)	Hcb kA/m	(Oe)	(BH)max kJ/m³	(MGOe)
1)	LN10	680	6800	40	500	9.6	1.29
	LNG13	700	7000	40	500	12	1.50
	LNG37	1200	12000	48	600	37	4.63
	LNG52	1300	13000	56	700	52	6.50
China	LNGT38	800	8000	110	1380	38	4.75
	LNGT72	1050	10500	112	1400	72	9.00
	FLNG12	700	7000	40	500	12	1.50
	FLNG28	1050	10500	48	580	28	3.50
	FLNGT31	760	7600	107	1340	31	3.90
1) GB1153-84	FLNGT33J	650	6500	136	1700	33	4.15

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Table 8. Magnetic Property of Rare-earth Type Permanent Magnets

Coun-try	Model	Alloy type	Br(G) (Minimum value)	Hca(Oe)	Hcj(Oe)	(BH)max (MGOe)
China	XG 80/38	$Ce(CoCuFe)_5$	6000	4000	4500	8~11
	XG 96/40	$Ce(CoCuFe)_5$	7000	4500	5000	11~13
	XG112/96	$SmCo_5$	7300	6500	12000	13~15
	XG128/120	$SmPrCo_5$	7800	7000	15000	15~17
	XG144/120	$SmPrCo_5$	8400	7600	15000	17~19
	XG160/96	$SmPrCo_5$	8800	8000	12000	19~23
	XG196/96	$SmPrCo_5$	9600	8700	12000	23~26
	XG196/40	SmCoCuFe	9800	4800	6000	23~25
	XG200/44	2:17型	10200	5200	6500	25~28
	XG240/48		10700	5500	5800	28~31

Table 9. Magnetic Property of Nd-Fe-B Permanent Magnet

Country	Manufac-turer	Model	Br (Gs)	Hca (Oe)	Hcj (Oe)	(BH)max (MGOe)
China	A branch in Ministry of Metallurgy		11800~12700	7000~10000		33~37
			11800~12400	7000~8500		33~35
	An insti-tute in Ministry of Electronics	NF25	10000~11000	6000~7000		25
		NF30	11000~12000	7000~8000		30
		NF35	12000~12500	8000~9000		35
		NF40	12500~13000	9000~10000		40
	A certain plant	XTS-30	≥11200	≥7670	≥7600	28~33
		XTS-35	≥11800	≥7800	≥8000	33~38
	A certain plant	NTP200/84	10500~11500	7500~9500	8000~10000	24~27
		NTP230/72	11200~12000	7500~10500	9000~11000	27~31
		NTP280/80	11800~12500	8000~11000	10000~12000	31~38

Referring to the comparison table of magnetic property of ferro-oxides, the quality analysis of our country's products shows that at the present time, with the exception of the few number of products and the products by some individual corporations whose performances are good, there is a vast gap between the majority of the products and the international level, in addition to some distance in shape, appearance and size of the products.

The performance of our AlNiCo is not too low when compared with the international level, and is basically the same as the IEC standard. However, the performance of the products from the majority of the plants in our country are low compared with those from Japan and the United States. Those that are compatible with the international advanced levels are only a few plants and a portion of the products. The large magnetic dispersion in the products is a striking problem in quality at the present time, as well as a critical factor affecting the export for the products. Low magnetic capacity models among AlNi products constitute over 60 percent of AlNiCo gross production volume.

As for the magnetic properties of rare-earth cobalt and Nd-Fe-B, our country's standards are not lower than the levels achieved by advanced countries, and the performance of the actual products is not inferior. Nevertheless, some efforts are needed in the area of oxidation resistance.

The performance of our country's Fe-Cr-Co is relatively high. There are too many varieties of adhesive permanent magnets that have been developed in our country. For some varieties, for example, the performance of adhesive rare-earth cobalt is approaching the international standard.

VI. Production Volume and the Market

The statistics on our country's permanent magnet production volume is managed by several departments, and there is no exact statistical data. The AlNiCo produced by the 13 plants under a ministry in 1985 total 1,604 tons while the national annual production of AlNiCo is about 2,500-3,000 tons which is the same as Japan, the United States, and Western Europe. The AlNi which has dominated for 40 years began a rapid decline worldwide in the late 1970's. The current productions in the United States as well as in Japan are only maintained at one-fifth of the peak production, with many plants manufacturing some other products or even discontinuing the production. At the present time in Western Europe, there are only six manufacturers in the production of AlNiCo. On the other hand, the manufacturers of AlNiCo in our country are mushrooming, and the peak production should have been reached by now; otherwise, it will be like what a Chinese proverb says "The gruel is meager and the monks are many"--not enough to go around--resulting in the worsened phenomenon in which Ni, Co are being wasted. The national annual production in ferro-oxide permanent magnets is about 10,000 tons. The worldwide production of inexpensive ferro-oxides, with their acceptable performance, has gradually ascended as the top in permanent magnet production since the 1970's. It has now constituted over 94 percent of all permanent magnet production. Half of the ferro-oxides are used in amplifiers. The most extensive market in the years to come will be the need in permanent-magnet generators. In the West it is believed that within the coming 10 years, ferro-oxides will develop at an annual rate of 8 percent. The demand in ceramic generator magnets will continue to exceed the supply during the next several years. The production of ferro-oxide products having higher performance fails to meet market demand, and there is a shortage emergency abroad while we cannot export in high volume. Ferro-oxides will develop tremendously and possibly push their way into international market provided

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their performance can be steadily improved. Our national production in rare-earth cobalt is about 20 tons per year, constituting less than 2 percent of world production. Our country has 84 percent of the rare-earth resource in the world. The cost of cobalt as with other rare-earths is very high. In addition, because of the expansion of applications, slow growth in cobalt production results. In Western countries, the production of cobalt permanent magnets doubles every 2 to 3 years, with 280 tons of production in 1981, 480 tons in 1983, and 1,150 tons in 1985. The growth rate is extremely fast. The United States' efforts started in the defense industry while in Japan, they are focused on civil applications, both have developed very rapidly. Japan, the United States, and Western Europe are accelerating the commercialization of Nd-Fe-B, and actively developing applications. A similar situation has emerged in our nation. Because of the superior performance of Nd-Fe-B, not so difficult processing technology and our vast resources, some 80 manufacturers and institutions in the country were highly stimulated and they jumped in all at once with overwhelming momentum. As in a Chinese proverb "The temples are many and the visitors are few," the supply exceeds demand. However, one should note that it is highly competitive. A favorable pricing situation has appeared abroad. The price of unit magnetic capacity in 294.52 kJ/m^3 (37MGOe) of Nd-Fe-B is one-tenth of $SmCo_5$, one-fifth of $AlNiCo_8$, and even cheaper than 27.86 kJ/m^3 (3.5MGOe) of ferro-oxide. Thus, with the growth in production and the development in inexpensive mixed neodymium rare-earth ferromagnets, it could have a bright future, provided that its temperature characteristics can be further enhanced.

[Table 10 not reproduced]

Table 11. Japan's Production Volume and Value in Permanent Magnetic Materials From 1983 to 1985 (Unit: ton; ( ): value in 100 million yen)

Year	Ferro-oxides	Fabricated permanent magnet	Rare-earth permanent magnet (sintering)	Other perm. magnet	Total	Adhesive ferro-oxide permanent magnet	Adhesive rare-earth cobalt permanent magnet
1983	58,800 (429)	2,550 (122)	281 (120)	4 (2)	61,700 (672)	10,000 (94)	29 (13)
1984	70,100 (542)	2,620 (128)	430 (180)	5 (2)	73,200 (852)	11,750 (105)	50 (20)
1985	71,618 (575)	2,273 (114)	451 (191)	14 (5.7)	74,356 (885.5)		

Table 12. Average Price of Japan's Permanent Magnet (Japanese yen/kg)

	Ferro-oxide permanent magnet	Al fabricated permanent magnet (primary AlNiCo)	Rare-earth type permanent magnet
1983	729	5,945	42,599
1984	773	4,891	41,770
1985	798	4,998	42,984

For any new permanent magnetic material in our country, it usually takes 5 to 10 years from its inception to be applied extensively. Because of such factors as awareness, price, engineering equipment and tools, application technology, etc., new product expansion is sluggish, resulting in a situation that the supply exceeds the demand. This could not be regarded as an abnormal situation, and it could be changed step by step with the progress in science and technology, along with economic development.

VII. Two Remarks

We have two remarks regarding how to vigorously develop the permanent magnet business.

1. Intensify fundamental research and improve manufacturing technology.

In order to change the copying stereotype of permanent magnetic materials in our country, we should conduct an in-depth study on the micro-structure and the systematic study on the phase diagrams of the materials, as well as explore the measurement of basic parameters of the materials. We should also start the processing technology research on special systems as well as the research and manufacturing on specialized engineering equipment. In addition, specialized plants and institutions should be organized in a supporting role for the manufacturers of permanent magnets, forming a technical force and the manufacturing technology capable of competing with other foreign countries. As for the existing material production, the processing techniques should be perfected, management and controls should be intensified and strengthened so that product quality can be improved, the production of quality products can be stabilized, and the products can achieve the international advanced level rapidly, satisfying domestic needs and gaining entry into international market as well.

2. Actively expand the study in applications, and the development in testing techniques.

Application and testing techniques are two important rings in the overall engineering of permanent magnet system. The illogical situation in which application study lags new product development should be completely changed for good so that materials can find fast, prompt, logical and realistic applications. The testing and control techniques in production process have a bearing on the quality, application, cost and economic benefit in the products, thus adequate attention and endeavor are warranted.

COMPUTER ENTERPRISES JOIN TO FORM ECONOMIC GROUP

Beijing DIANZI SHICHANG in Chinese No 52, 25 Dec 86 p 1

[Report by Wang Zhiping [3769 1807 1627]: "Great Wall Computer Group Established in Beijing"]

[Text] The largest computer integrated complex in this country--the organization comprised of the Great Wall Group, has undertaken a beneficial exploration of the question: after enterprises go to lower levels, how is the administrative separation to be implemented by departments and regions in a synchronized way. The Great Wall Group will rely on Beijing for support, will break up created barriers, and will implement lateral associations with microcomputers, minicomputers, mainframe computers, and programmed exchanges as key products, and will adjust and restructure the modes of production operations to constitute an enterprise group that integrates research, production, applications, service, and education.

After enterprises in the capital had gone to lower levels, the Ministry of Electronics Industry once negotiated with Beijing Municipality to consider the computer industry as a test site in which to transfer operations management authority directly to the enterprises, thereby better handling the system restructuring. Currently, there are 67 enterprises and facilities that are part of the Great Wall Group, among which are 5 colleges and 4 institutes, with a staff of more than 50,000, and more than 28,000 scientists and technicians. This has allowed the Great Wall Group to become a new type of enterprise group that concentrates intellectual resources.

The Great Wall Computer Group is free-form, composed of both very close levels and also loose levels. The very close levels practice one-from-four, that is, they unify planning, unify development, unify marketing, and unify accounting; the loose level accepts the direction and support of the Great Wall Group. The focus of development for the Great Wall Group is to form a "four-headed dragon" from microcomputers, minicomputers, mainframe computers, and programmed exchanges, as well as to constitute a development and service capacity for systems engineering.

The organizational model for the Changcheng Group is:

1.   In the situation where the four unify under one, to organize joint operations for "the whole process" for new products and systems;

2.   to constitute a joint-stock company in which the economic factors of manpower, material resources, technology, work places, equipment, instrumentation, and markets are joined together through shared stock to accomplish the economic goals that have been determined;

3.   the Great Wall Group has been authorized by the state to trade stock in the name of the state among joint-stock companies.

The founding meeting of the Great Wall Computer Group was held 17 December. Comrade Bo Yibo [5631 0001 3134] will be the nominal head of the company.

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CSO: 4008/1040

NEW PHASED NOISE TEST DEVICE DEVELOPED

Beijing DIANZI SHICHANG in Chinese No 52, 25 Dec 86 p 5

[Report by Liu Xiuwei [0491 0208 0251]: "New Type of Phased Noise Test Instrument"]

[Text] Recently, the Qianfeng Radio Instruments Plant of the Ministry of Electronics successfully developed the Model QF4022 phased noise test instrument, having an advanced level of the 1980's, which fills a domestic void.

This instrument is primarily for use in the measurement of frequency short-term stability for highly stable signal generators from 2 MHz to 500 MHz.   It may also be used to test phase modulation noise of components such as frequency multipliers and wideband amplifiers, and may act as well as a broadband synchronizing apparatus and as a frequency calibrator. Its internal terminal portion is a broadband frequency selecting level indicator of excellent performance that can be used by itself.

Currently, the characteristics and quantitative measurement of phased noise are displaying their importance more and more.   In RF and microwave systems, phased noise is an important limiting factor. For example, whether or not communications channels can be even narrower, whether or not the sensitivity and selectivity can be improved furthe,r and the resolution of radar and the error rates for digital communications, these are all determined by the phased noise of systems themselves. Similarly, whether or not radio measurement instruments can meet the demands just described are also determined by the phased noise index of the instruments themselves.   A great deal of money has been spent to improve phased noise.

Test production of this instrument has been successful, and it will make contributions to the catching up to and exceeding of international advanced standards by electronics technology in this country during the "Seventh 5-Year Plan."

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CSO: 4008/1040

DEVICE TO AID PRINTED CIRCUIT BOARD PRODUCTION ANNOUNCED

Beijing DIANZI SHICHANG in Chinese No 52, 25 Dec 86 p 5

[Report by Sheng Tao [4141 3614]: "The Model HR500-II Automatic Temperature Controlled Infrared Smelting Furnace"]

[Text] The HR500-II Automatic Temperature Controlled Infrared Smelting Furnace is specialty equipment for use in printed circuit board (PCB) production lines. It controls temperatures with a microprocessor, heating with infrared wires, and will heat and melt the lead-tin alloy used on printed circuit boards, forming an equally dense alloy, which allows a secure combination of the lead-tin alloy with the copper-platinum, consequently improving the solderability and reliability of PCBs, and ensuring the PCB quality.

This machine uses microprocessor automatic control and can implement temperature control within a broad range, and its sampling time and adjustment parameters can be randomly set and selected. It has real-time temperature display and excess temperature alarm features, is small, stable in transmission, has highly efficient melting, and the process for melting the PC's is safe and reliable.

When compared with similar foreign products, this machine has the advantages of being smaller, lighter, consumes less power (each similar foreign product consumes 60 kw, while this machine consumes 13), is reliable, and is inexpensive (similar foreign products are $27,000, which is 23,000 yuan).

The Chengdu Academy of Telecommunications in Sichuan is at present the first plant in this country to manufacture this infrared smelter, and products of this sort from this plant are already for sale in more than 10 provinces and cities throughout the country, and they have been well evaluated by customers.

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CSO: 4008/1040

BRIEFS

MICROCOMPUTERS IN FORESTRY MANAGEMENT--In cutting-area design at more than 80 percent of the forestry offices in Jilin Province, microcomputers have displayed their great abilities, bringing about a tenfold improvement in work efficiency and gaining direct economic results of more than 1 million yuan. Jilin Province is one of the important forestry production areas in this country, and in the past the design of cutting areas were all manual operations, there was great labor intensity, many people were involved, the work period was long, and usually, even with overtime it was difficult to accomplish the design tasking on time. To satisfy the urgent demands of the first line, scientists and technicians of the Jilin Province Institute of Forestry Sciences went deep into the forests, courageously explored, and after more than 2 years of arduous effort and more than a year of testing, they created a new alternative for using microcomputers for cutting-area design. Beginning in June this year, 14 forestry offices in Jilin Province were using microcomputers for cutting-area design. [Text] [Beijing DIANZI SHICHANG in Chinese No 52, 25 Dec 86 p 1] 12586
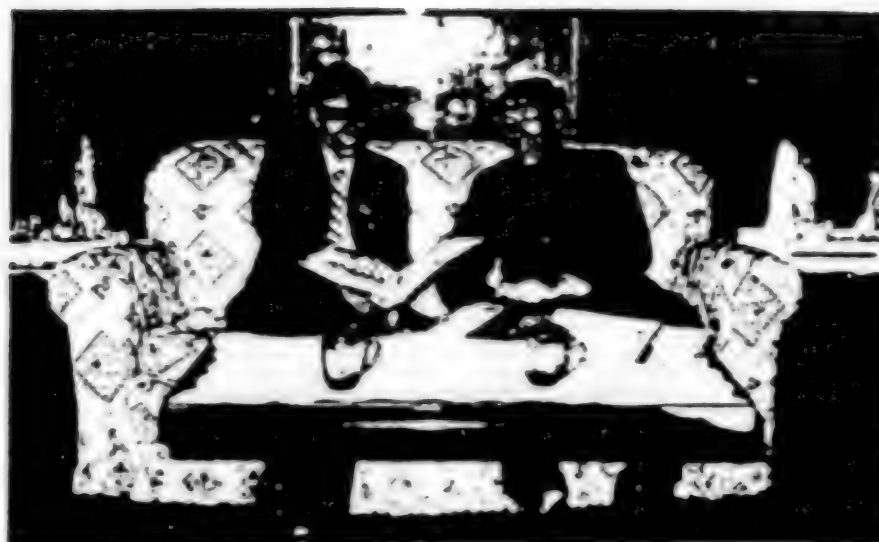
CSO: 4008/1040

SHANGHAI INSTITUTE OF PROCESS AUTOMATION INSTRUMENTATION

Shanghai ZIDONGHUA YIBIAO (PROCESS AUTOMATION INSTRUMENTATION) in Chinese
Vol 7, No 9, Sep 86 pp 1-2

[Text] Shanghai Institute of Process Automation Instrumentation was founded
in October 1956. Its primary function is in the research, development, pilot
production and application of instrumentation in process automation. It is
responsible for the development of complete automatic control systems and
tackling technical issues for key national engineering projects in China. It
is a comprehensive research organization in detection, display, adjustment,
control, implementation and feedback control technology in process automation.
The China Quality Monitoring and Inspection Center for Process Automation
Instrumentation Products and the Inspection Station for Explosion Resistance
and Safety of Instruments and Meters on the National Level are located at the
institute. It is the organization in charge of technology development plan-
ning and standardization for the process automation instrumentation industry.
It is a member of TC65 of the International Electrical Engineering
Committee (IEC) and TC30 of the International Standardization Organization
(ISO). It is responsible for the process automation instrumentation
information network in the Ministry of Machine Building. The Process Control
Instrumentation Society in the China Instrumentation Society and the
instrumentation and Device Committee in the China Automation Society are
affiliated with the institute.

The institute has a total of 976 employees, including 590 technical
personnel. It has a system engineering department, and research offices and
laboratories in temperature instrumentation, flow instrumentation, mechanical
quantity instrumentation, ultrasound instrumentation, isotope instrumentation,
display instrumentation, navigation instrumentation, actuators, industrial
control computers, reliability and adaptability, technical standards and
technological intelligence. In addition, there is a pilot plant with close
to 200 employees. The institute has sufficient technical strength and is
equipped with advanced experimental apparatus to offer various technical
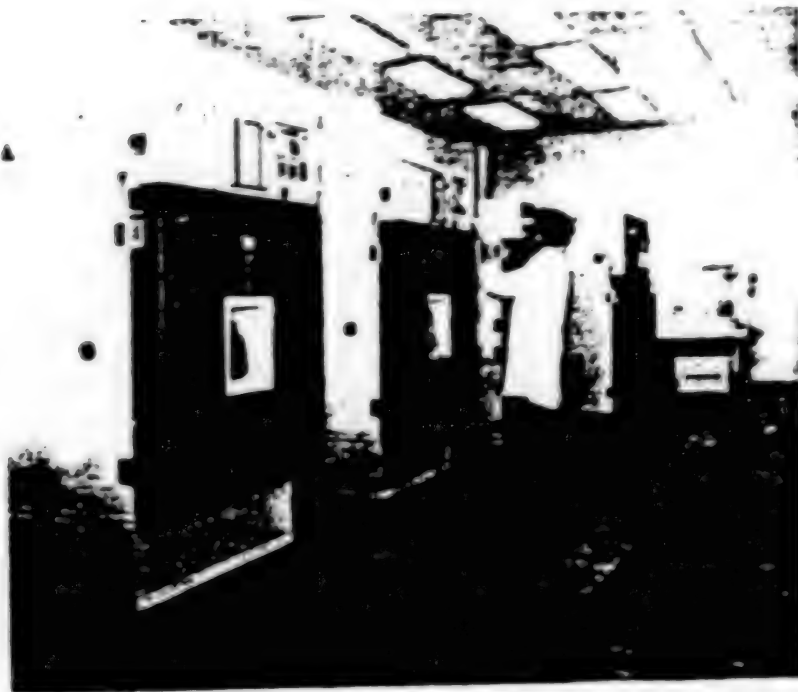services to all industries in process automation.

▲现任所长范建文和前任所长吴钦纬在一起

Current Director Fan Jianwen [5400 1696 2429] and Former Director Wu Qinwei
[0702 2953 3555]

Birdseye View of the Shanghai Institute of Process Automation Instrumentation

▼ 仪器仪表环境试验台第一角

Environmental Testing Laboratory for Instruments

▲为营口港500万吨煤码头研制的计算机控制与管理系统

Computer Control and Management System Developed for the 5,000,000 Ton Coal
Pier at Yingkou Harbor

Assembly Shop in the Pilot Plant

Computer Center

2D CHINESE MARINE REMOTE SENSING SYMPOSIUM HELD IN HANGZHOU

[Article by Du Ronghua [2629 2837 5478]]

[Text] The Marine Remote Sensing Special Committee of the China Oceanography Society and the Chinese Oceanography and Limnology Society convened the second representative assembly and scholarly conference on Apr 11-14, 1986, in Hangzhou. In attendance were 77 representatives of 34 units engaged in remote sensing research such as the Chinese Academy of Sciences, the State Oceanography Bureau, the State Science and Technology Commission, the State Meteorological Administration, the State Aquatic Products Science Research Institute, the Ministry of Astronautics, and higher academics.

This symposium received 64 papers, of which 54 were read and circulated. The participants gained further understanding of the present state and future direction of domestic and foreign marine remote sensing from the reports of Wu Keqin of the National Marine Bureau's Science and Technology Information Research Institute, Lu Zhigang of the Chinese Academy of Science's Space Science and Technology Center, Jiang Linshan of the Ministry of Astronautics' Institute 501, and Guan Fumin of the Shandong Academy of Oceanography on "The Present State of Chinese Marine Remote Sensing," "Balloon Remote Sensing," "Designs for Satellite Marine Remote Sensing," and "A 10-Year Look Forward for Marine remote Sensing." The other 50 papers were read and circulated in 6 separate sessions. These papers dealt with the application of remote sensing technology to comprehensive surveys and exploitation of coastal and marine resources, to the motion of suspended silt in river mouths and near shore zones, to ice-floe detection, and to marine fisheries predictions.

Remote sensing research began in China in the 1970's, a bit later than in Western countries. By the late seventies, this science had formed a preliminary scale marine remote sensing research corps, dispersed in oceanography, fisheries, communications, and higher academics. In recent years, China has obtained outstanding achievements in developing methods of remote sensing physics, wave spectrum measurement, and information processing as well as in marine element remote sensing and basic theoretical research and methods in other research areas. Since 1978, relevant departments have also developed from north to south a series of coastal space remote sensing flights. Several

examples prove that the application of remote sensing technologies in coastal motion land description and resource surveys have produced notable positive economic results. Our remote sensing work is presently largely concentrated on the continental shelf region. After a satellite material collection system and reference archives are established in the late 1980's, we can expect to have a large quantity of developments in marine fisheries, long distance navigation, coastal exploitations, in addition to large- and medium-scale marine physics.

The majority of representatives participating in this symposium were young and middle-aged workers in science and technology. At the conference the atmosphere was scholarly and the overall atmosphere lively. The participants all felt that the development of remote sensing technology was shadowing new international technological developments, transforming the less developed situation of environmental science in China, and revolutionizing the basic policy of following old ways in marine surveys and scientific research. Based on the special discussion of the question of how to further advance marine remote sensing research work, the representatives had the following proposals for the concerned agencies: 1) As quickly as possible form a special team which, using systematic engineering methods to carry out a total design, would propose comprehensive methods for the middle period of national remote sensing work; 2) The present applied and basic research work should not be entirely set up in China alone nor should it be based entirely on planned marine satellites. Rather, we should strengthen international exchanges and apply all presently available scientific results from around the world; 3) Rationally clean up or arrange the present satellite information processing system, obtain relevant marine satellite material through international cooperation, intensify the marine sensing portion of Chinese resource satellites to participate in global cooperation and exchange, and supplement the funds for basic research questions; and 4) do a good job of remote sensing data service work.

The authors of 20 papers selected by assessment of the symposium will participate in the International Remote Sensing Technology Symposium to be convened this November in Beijing. The conference plans to publish a collection of marine remote sensing essays (English edition) to facilitate international scholarly exchange.

After the symposium, a second board of directors meeting was also convened to study and discuss the major duties and organizational structure of the association.

INTERNATIONAL SYMPOSIUM ON ELECTRON OPTICS

Beijing DIANZI XUEBAO [ACTA ELECTRONIC SINICA] in Chinese Vol 14　No 6, Nov 86 p 90

[Article by Ximen Jiya [6007 7024 4764 0068], Zhou Liwei [7019 4539 0251], and Zhu Xieqing [2612 0588 0615]]

[Text] On Sep 9 to 13, 1986, the Chinese Electronics Association and its Vacuum Electronics Association convened the International Symposium on Electron Optics, Beijing, 1986, undertaken by the Chinese Academy of Sciences Electronics Institute. Attending this meeting were nearly 50 American, West German, Japanese, French, Czechoslovakian, and Soviet scholars and over 100 Chinese scholars and representatives. One hundred papers were presented by these scholars. The topics of discussion at the meeting included broad ranging areas such as fundamental theory and experimental results of electron and ion optics, electron and ion optic systems, electronic computer-assisted design, image processing, and electron holography. The papers and reports of the meeting proved that at present electron and ion optics is an extremely lively discipline and is developing important applications in the leading realms of advanced technology. These scholarly reports abundantly reflected new international and domestic achievements and results in the area of electron optics, examples of which are given below.

Computer aided design (high order finite element methods, improvements in integral equations methods, solutions of three dimensional fields, optimalization design, and computation of nonaxial and nonsymmetric perturbations; applying tensor analysis, group theory, and other generalized methods in electron optics; development of aberration theory (multipole system aberration and high order aberration); particle optics of bent axis spectrographs; electron optic problems in focusing--deflection composite system theory and submicron electron beam ion increased detail process technology (femitron sources, liquid metallic ion sources, focusing--deflection composite system design, etc.); image processing, electron holography, and electron interference techniques; design of electron lens and design of new instruments (scanning electron microscopes, scanning transmissions electron microscopes, and photoelectron microscopes) and new studies of experimental methods; research on electromagnetic deflection systems and deflection aberration, traveling wave deflectors and transition intervals; wide beam electron optics and image tube design.

In recent years, Chinese scholars have engaged in broad and effective research work in the various areas of electron optics, attaining a great many important accomplishments. Moreover, in some areas, they have done innovative work reaching international levels which has drawn considerable attention from their foreign colleagues. This meeting proves that electron and ion optic research in China has advanced to the front ranks of world science.

INTERNATIONAL CONFERENCE ON SEMICONDUCTORS, IC TECHNOLOGY

Beijing DIANZI XUEBAO [ACTA ELECTRONICA SINICA] in Chinese Vol 14   No 6,
Nov 86 back cover

[Text] The International Conference on Semiconductors and Integrated
Circuits Technology jointly sponsored by the China Electronics Society and the
University of California at Berkeley was held 20-25 October 1986 at the
Xiangshan Hotel in Beijing. This was the first time that the international
community concerned with semiconductors and integrated circuits technology has
met in China. Over 300 scientists, scholars, academicians, and teachers from
14 countries came together to compare notes and techniques.

Nearly 300 papers were read at the conference on the 15 specialties of
silicon materials, photoetching, oxidation, diffusion, ion injection, thin
films, product completion rates and reliability, silicon material inspection,
processing inspection, integrated circuit production and clean room technolo-
gies, three dimensional solid integrated circuits, GaAs integrated circuits,
noncrystalline silicon thin films and various kinds of new devices. The
papers reflected the state of present research developments on the key
techniques of very large scale integrated circuits (VLSI) (such as fine photo-
etching, shallow etching techniques, transient state annealing, multilayer
wiring and interconnection of silicates, ultrathin oxidation layer production,
on-line inspection, and various purification and analysis techniques) as well
as related III-IV applied compounds, hetrojuctions, superconductors, and
other new electronic devices and models.

During the meeting, there were two special sessions carried out on VLSI
development trends and on Sino-foreign cooperation. Attending representatives
also toured Chinese integrated circuit factories, research institutes, and
institutions of higher education. They also engaged in wide-ranging scholarly
exchanges with scientific workers employed in production, scientific research,
development, and education.

Professor Wang Shouwu of the Chinese Academy of Sciences Education Bureau
served as the chairman of this meeting. The conference received the
energetic support of Chinese and foreign scientists and scientific bodies.
Professor Wang Yangyuan of Beijing University and the entire membership of
the "American Committee" made a great contribution toward the organization of
the conference.

Among the well known specialists participating in the conference were professor (Nikelin) of the University of North Carolina, (Miles Smith) of AT&T, professor Zhang Hengtang of the University of California at Berkeley, (Dakai Xi) director of the Toshiba VLSI research institute in Japan, Nagata Minoru, general engineering instructor of the Hitachi Center laboratories in Japan, Wang Shoujue, member of the Chinese Academy of Sciences Education Bureau, professor Li Zhijian of Qinghua University, and professor Huang Bi of the Shaanxi Microelectronics Institute. Also attending this conference were consultant Li Zhaoji and director Li Xianglin of the State Council Electronics Industry Invigoration Leading Group's office, vice director Liu Jianfeng of the Ministry of Electronics Industries, and Sun Junren, council head of the China Electronics Society.

The convening of this conference will assist in strengthening Sino-foreign friendship and cooperation and will actively work for the development of Chinese integrated circuit technology.

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